Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JANUARY, 1951

TECHNOLOGY DEPT.

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JAN 27 1951
DETROIT

Increase Cold Mill Production with... MESTA-THOMSON FLASH WELDERS

Mesta-Thomson Flash Welder installed in a Mesta High-Speed Continuous Pickling Line

REPRODUCTION BY E.D. MESTA

MESTA MACHINE COMPANY
PITTSBURGH, PA.
Designers and Builders of Complete Steel Plants

R v.28 Jan.-June 1951

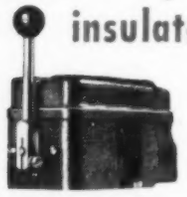
New Cam Operated MILL ACCESSORY MASTER

Has 3 separate insulated circuits

"FIVE BY FIVE"

Actual size of case 5½ x 5¼ x 5½

Also in 6 separate insulated circuits



Case measures 5½ x 5¼ x 8⅛

The new Cutler-Hammer Mill Accessory Master has been designed for the many steel mill applications where a cam operated type master switch of very small dimensions is required. This new small master is available with either 3 or 6 separate insulated circuits; cast iron case for surface mounting and in skeleton or sheet metal case for back-of-panel or bench-board flush mounting.

Five standard models are available for these usual types of magnetic controllers:

1. Single speed reversing without low voltage protection in the 3 circuit master.
2. Single speed reversing with low voltage protection in the 3 circuit master.
3. Two speed reversing without low voltage protection in the 3 circuit master.
4. Two speed non-reversing with low voltage protection in the 3 circuit master.
5. Single or two speed non-reversing or reversing with or without low voltage protection in the 6 circuit master.

In addition, both the 3 circuit and 6 circuit master may be had with "daisy-petal" twist-off cam elements adaptable to special circuit requirements . . . which enable you to stock a supply of these masters and tailor each to the requirements of each application.

The switch is provided with double break bridging contacts, molded arc-resistant arcing chambers. The switch has positive star wheel action with readily adjustable star wheel tension. Star wheel cam and roller, and switch cams and rollers, are case hardened. The cam shaft is mounted on self-aligning ball bearings. Handle can also be furnished as self-centering from either or both directions. The clamp-on type handle is readily adjustable to any angular position. The cast iron case of the surface type enclosure has conduit openings in both sides and one in the bottom. The switch is easy to wire, with solderless type lugs; each terminal is arranged for two wires. Rugged construction assures low maintenance. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

where can YOU use this new mill accessory master?

HERE ARE BUT A FEW OF MANY PRESENT USES:

Blowers	Lifts	Pickling Tanks
Conveyors	Saws	Sizing Mills
Electric Heaters	Machine Tools	Solenoid Valves
Kick-offs	Mandrel Extractors	
Levelers		

A pair of pliers does the trick!

When You Tailor This Master To The Job

When there are special circuit requirements to be met, both the 3 circuit and 6 circuit masters are available with "daisy-petal" twist-off cam elements which can be "tailored" to the needs of the specific job. Petals can be twisted off with a pair of pliers to form any cam arrangement.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 28, No. 1.

Cold Drawing at American Brass

DRAWBENCHES

• Close-up of a triple draw Aetna-Standard Bench at The American Brass Company, Kenosha, Wisc.

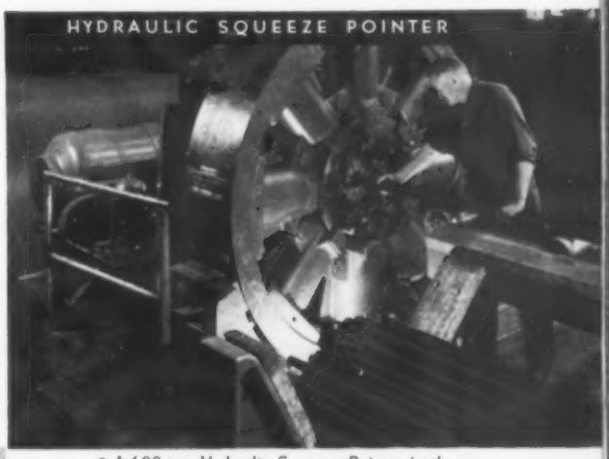
with Aetna-Standard equipment

• Improving plant facilities and equipment is a continuing program of The American Brass Company, manufacturers of Anaconda Brass and Copper Products. In conjunction with this program, Aetna-Standard has been one of the suppliers. The engineers of both companies cooperate closely in choosing the proper equipment. These installation views of Kenosha, Wisc., are typical of the over-all American Brass program.

Aetna-Standard makes equipment for all phases of Tube Drawing, from billet to finished tube. In addition to the three products illustrated here, Aetna recently introduced a Horizontal Bull Block.

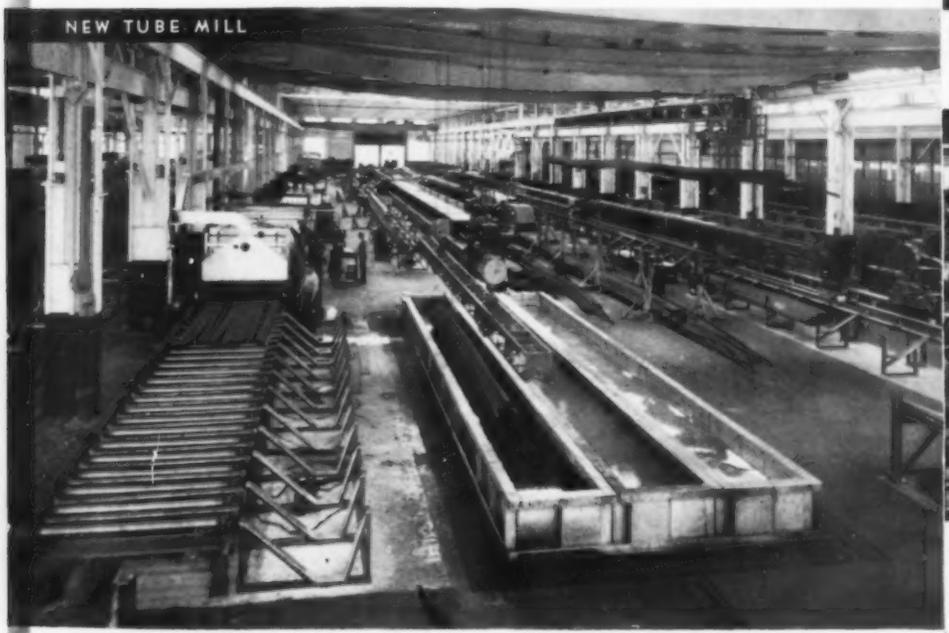
Aetna-Standard has specialists in all phases of cold drawing. Call on these tubing and cold draw specialists for assistance in designing and building proper equipment for your requirements.

HYDRAULIC SQUEEZE POINTER



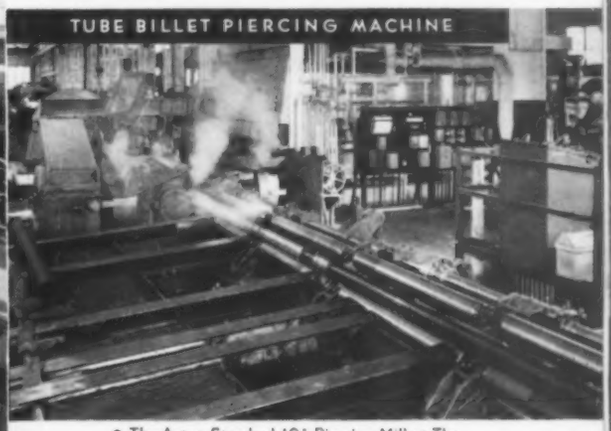
• A 600-ton Hydraulic Squeeze Pointer in the Kenosha, Wisc., plant of The American Brass Company. This firm also installed a 300-ton Aetna-Standard Squeeze Pointer.

NEW TUBE MILL



• Ten Aetna-Standard Drawbenches at The American Brass Company, Kenosha, Wisc. They include (3) 100,000 lb.; (3) 36,000 lb.; and (4) 12,000 lb. benches.

TUBE BILLET PIERCING MACHINE



• The Aetna-Standard 19" Piercing Mill at The American Brass Company, Kenosha, Wisc.

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

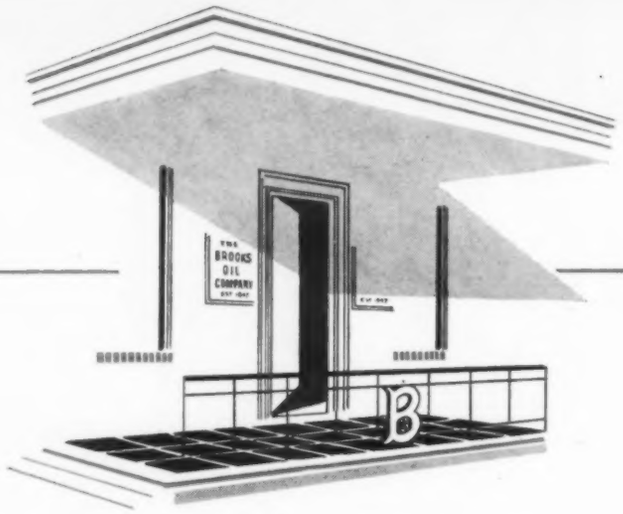
Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

aetna-standard

THE AETNA-STANDARD ENGINEERING COMPANY · YOUNGSTOWN, OHIO

Plants in Warren, Ohio · Ellwood City, Pennsylvania



Brooks says Thanks to You on our

75th Anniversary

Our steady growth is due to satisfied customers whose lubrication problems we have solved with LEADOLENE*

Through constant research and sound expansion policies Brooks has grown from a humble beginning to a position today as one of the country's major compounders of industrial lubricants. This history of three-quarters of a century of progress we owe to the good will of our customers. In recent years, when expansion has been particularly extensive, the greatest part of our growth has come from existing customers who have been well satisfied with the exceptional service of Brooks extreme pressure lubricants. By devoting 100% of our research, engineering and production facilities to only one thing—the compounding of industrial lubricants—we hope to continue supplying engineering service and lubricants for the tough jobs in industry.

Write . . . for this new 24-page booklet which describes the business policies and background of our company, and includes many case histories which show how Brooks extreme pressure lubricants are serving industry.

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Warehouses: In Principal Industrial Cities

*LEADOLENE . . . the "I. P. Lubricant" (Indestructible pH-ilm) . . . for Industrial Needs

3 Production Benefits from this Remarkable Instrument

1. Closer Combustion Control
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3. Productivity Raised

The Cities Service Heat Prover Analyzes Combustion Atmospheres of Industrial Furnaces

Regardless of type or size of furnace, atmospheres vital to steel production are quickly, accurately and completely analyzed. With this one remarkable instrument it is easy to determine how much fuel is wasted, whether excess oxygen may be present to cause scaling and how much energy is wasted in uselessly heating excess air.

A complete line of petroleum products for the Metal Fabricating Industry including:

- **Chillo Cutting Oils**
- **Trojan Greases**
- **Trojan Gear Oils**
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For complete details, mail coupon today for your copy of "Combustion Control for Industry."

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QUALITY PETROLEUM PRODUCTS

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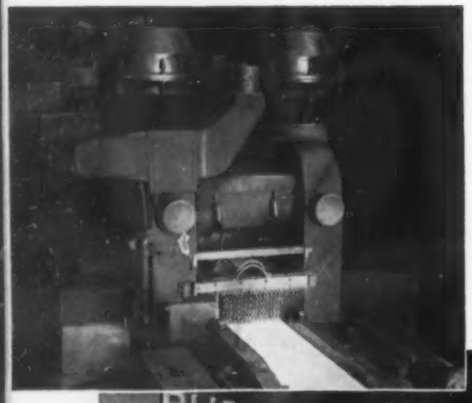
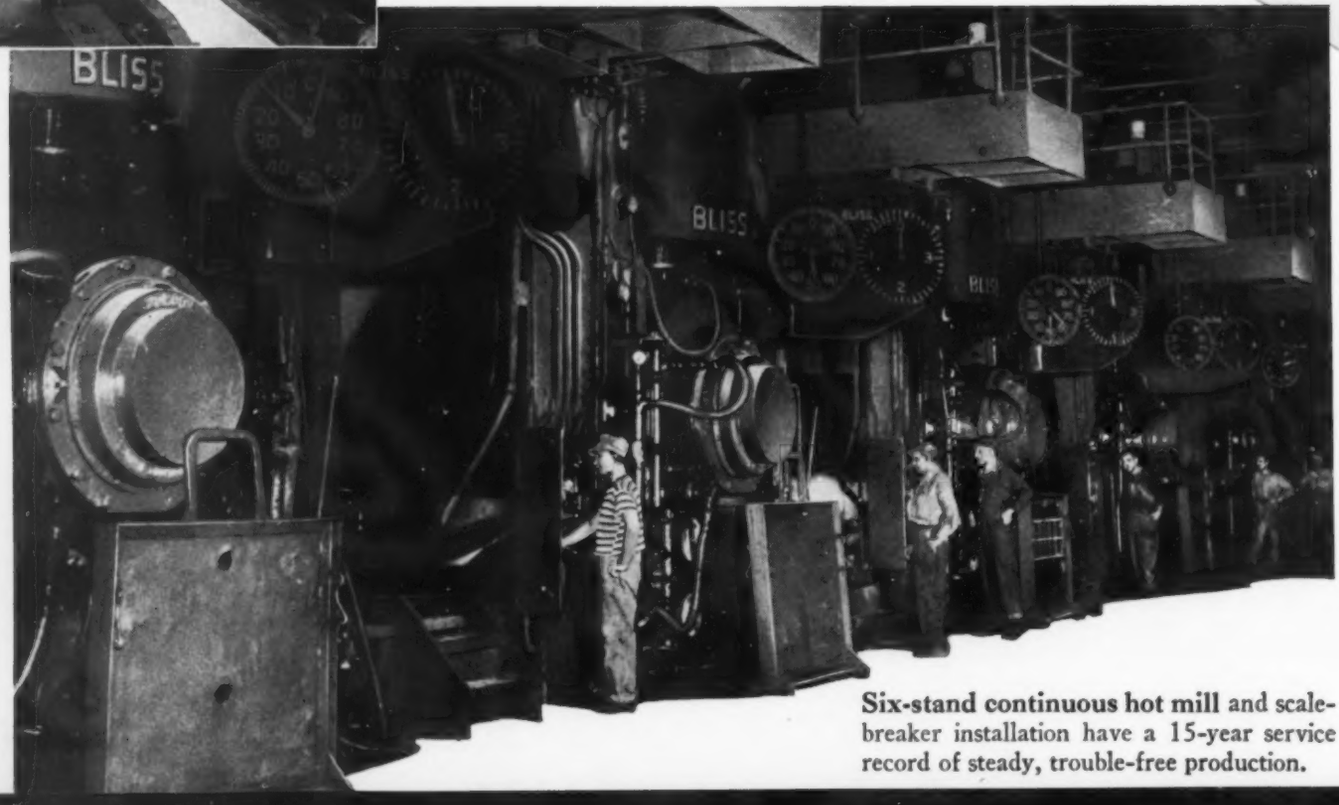
Bliss Mills Roll Record Tonnage at South's Leading Steel Plant



Scalebreaker prepares hot steel for continuous mill.



Six-stand continuous hot mill and scale-breaker installation have a 15-year service record of steady, trouble-free production.

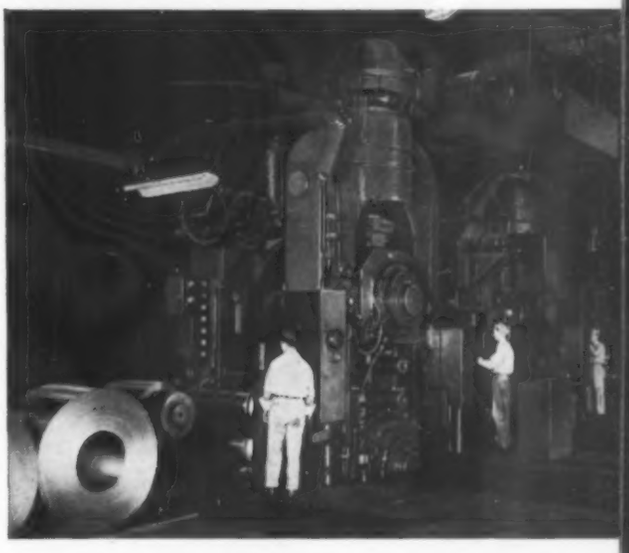
IN BOTH hot and cold rolling, production records are a habit at the South's leading steel plant. Here a complete array of Bliss mills produces quality metals to meet the growing demands of Southern industries.

A new Bliss four-high temper pass mill, for example, recently delivered a record tonnage in eight hours. And five Bliss two-stand tandem mills have produced beyond rated capacity since the first installation in 1938.

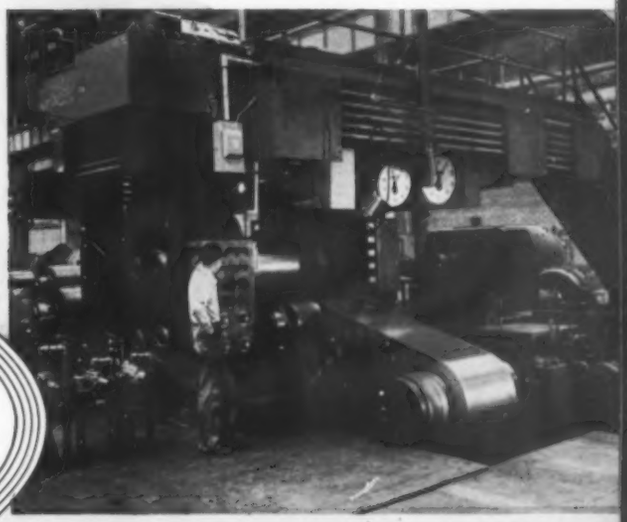
For hot breakdown and finishing, the Bliss scalebreaker and six-stand, continuous mill have given more than 15 years of steady performance without any trouble, taking round-the-clock operation so well that more powerful motors are being installed for even greater speed.

Whether your rolling is hot or cold, ferrous or non-ferrous, breakdown, rundown or finishing, Bliss mills are available to give you better-than-rated production. Built for precision work at maximum speeds, they take the abuse of continuous high-speed operation with least possible maintenance.

Four-high temper pass mill recently rolled a record tonnage of steel in eight hours. Above, it tempers 20-gauge steel at 3000 f.p.m., handles 30 to 13 gauge, 20″ to 48″ wide.



Four-high tandem mills produce more than capacity tonnage. Since the first of five such installations in 1938, they have delivered even beyond rated capacity. Material must meet exacting "specs" for flatness and temper.



Two-high mill is combination sheet and coil mill. It finish rolls 30 to 13 gauge...20″ to 48″ wide.

E. W. Bliss Company

General Offices: Canton, Ohio

Rolling Mill Division

Salem, Ohio

YOU SAVE TIME...

with every roll ground on a Farrel machine

Users of the latest type Farrel Heavy Duty Roll Grinder report that they are able to cut roll grinding time substantially.

They find the machine extremely fast for either heavy roughing or producing as high a mirror finish as it is possible to obtain with wheels at present available. Many automatic features simplify both set-up and operation. Setting-up time is held to a minimum.

Farrel machines grind straight, convex or concave rolls. The Farrel crowning device produces a mathematically accurate curve, symmetrical on both halves of the roll, for either a convex or concave shape, without manipulation by the operator. It is easily and quickly set and the same setting invariably produces exactly the same curvature and permits fixed, uniform and easily controlled accuracy of contour in all rolls.

Write for Bulletin No. 115 which describes in detail the many features of the Farrel Heavy Duty Roll Grinder. A copy of this 28-page bulletin will be sent to you without cost or obligation.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®

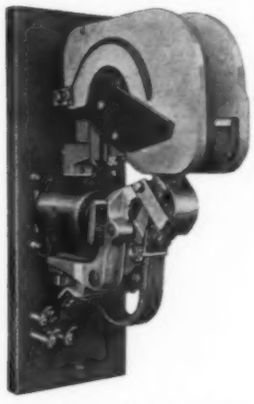
FB-647

ONE MILLION TONS OF ORE HANDLED—
ONLY 15 CONTACTOR-TIPS CHANGED
ON BOTH HOIST CONTROLLERS

HERE'S PROOF OF LOW UP-KEEP WITH

EC&M LINE-ARC CONTACTOR CONTROL

(TRADE MARK)

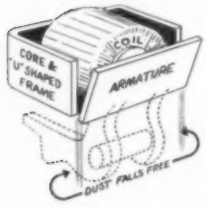


The world's fastest 600 ampere contactor.

One of the toughest jobs in steel mill service is the holding and closing line motions on ore bridges that raise and lower the bucket. In moving 1 million tons of ore in and out of the above stockpile, the hoist controllers operate frequently. Also, in spreading the ore on the pile, between loading and unloading, the number of contactor operations is doubled or even tripled.

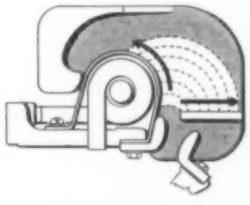
EC&M LINE-ARC Contactor Controllers on this ore bridge lived up to their reputation for low up-keep. Some hoist contactors operated almost a year before contacts needed renewing—both hoist controllers used only 15 sets of contacts in this handling operation. For *low* operating costs, specify EC&M LINE-ARC Contactor Control.

These Features contribute to LOW UP-KEEP . . . HIGH OUTPUT

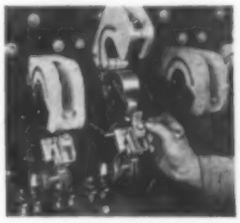


DUST PROBLEM LICKED
No mechanical shelf to catch and pile up dust.

SAFER INTERLOCKING
Two isolated, double-break contacts—no carry over.



COOL CONTACTS
Long life because of quick arc-transfer.



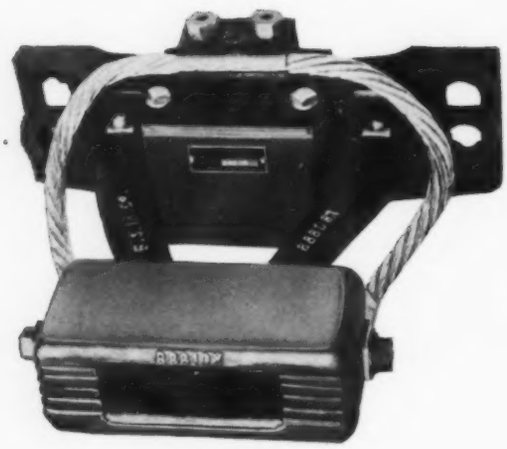
ENCOURAGES MAINTENANCE
Accessible front and rear contacts replaced in less than 2 minutes.

E&M

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79th STREET • CLEVELAND 4, OHIO

CONTINUOUSLY CONTACTS MAXIMUM RAIL AREA

TYPE LMI
PONY SIZE COLLECTOR . . .



NEW KEYSTONE RAIL COLLECTOR . . . EASILY MAINTAINED . . . REVERSIBLE

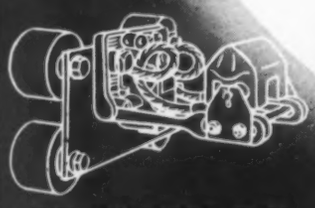
Want a rail collector designed throughout for efficient and simplified maintenance? Want shoes that have 30% greater travel? Then Keystone Contact Rail Collector Type LMI is your answer.

IMPROVED CONSTANT CONTACT . . . 300% more wearing thickness on each side . . . 26% increase in contact surface area. Large radii on all corners and edges permit shoe to traverse uneven conductor points smoothly . . . less wear.

Solderless shunt connectors and terminals—recessed into ends of shoe to insure long-lived non-loosening electrical connections. Generous bronze terminal clamps shunt and provides solderless connections for a variety of lead sizes.

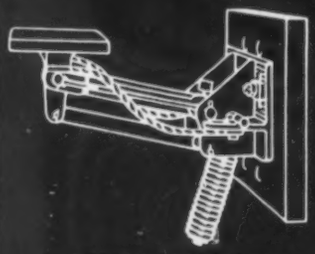
Adequate alignment provision . . . cool operation . . . efficient current transfer . . . rapid reversal . . . lower overall height . . . reversible . . . these are some of the many features of this new Keystone Contact Rail Collector.

There is a Keystone Contact Rail Collector to meet every requirement of steel mills. Write for Keystone Industrial Products catalog.



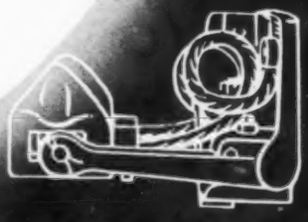
TYPE LMV SPECIAL SHOE

Four insulators; 2" horizontal movement. Other types of special contact shoes also available.



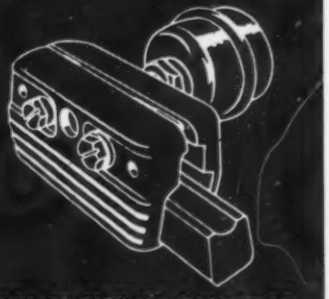
TYPE PS UNDER-RUNNING SHOE

For under-running service. Contact surface approximately 9" wide, 9" long.



TYPE LMV, PONY SIZE SHOE

For V 2" x 2" angle iron contact rails. Two contact surfaces, each 1½" wide, 5" long.



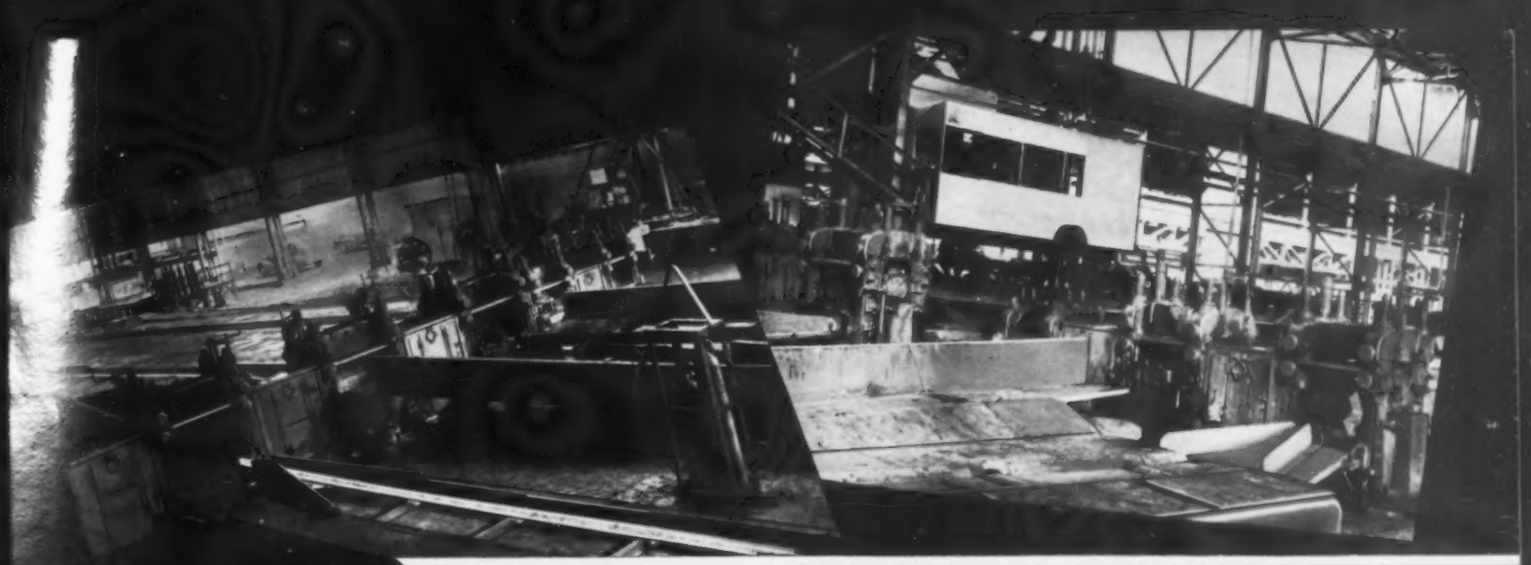
TYPE BI PICK-UP COLLECTOR

For wire conductors. Uses a removable carbon contact member.

ELECTRIC SERVICE MANUFACTURING CO.

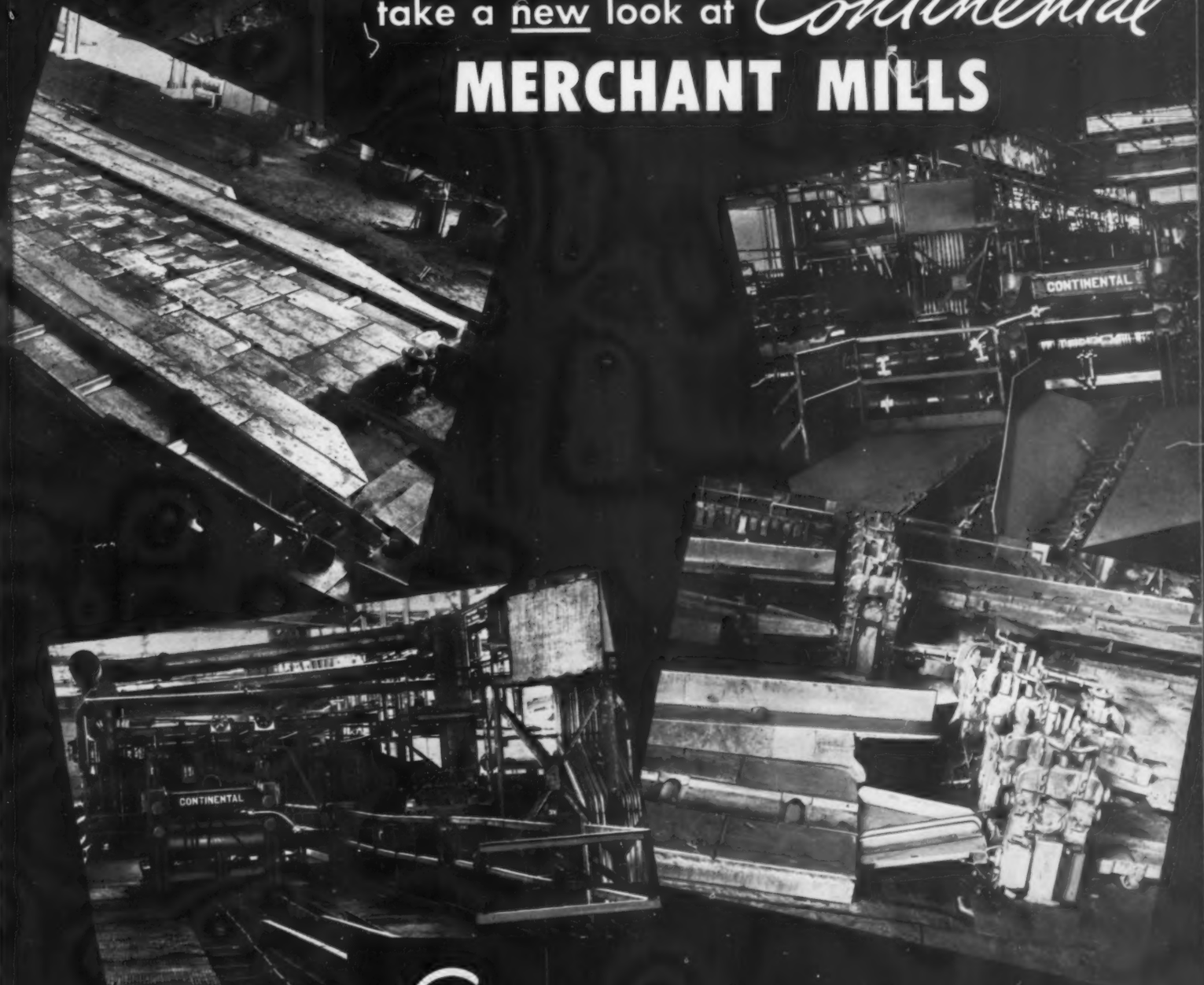
1721 CAMBRIA STREET • PHILADELPHIA 32, PENNA.

MAKERS OF CONTACT RAIL AND WIRE SUPPORTS, AND COLLECTION DEVICES



take a new look at *Continental*

MERCHANT MILLS



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FOUNDRY & MACHINE CO.

CHICAGO • PITTSBURGH

Plants at: E. Chicago, Ind.; Wheeling, W. Va.; Pittsburgh, Pa.

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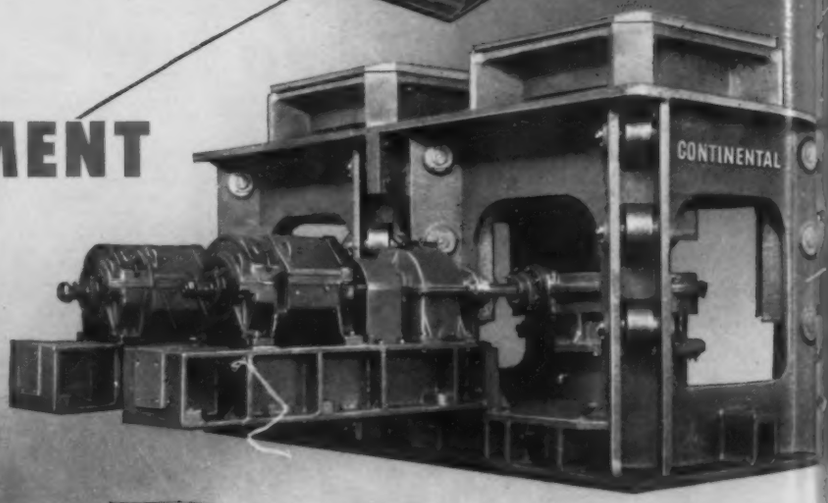
Iron and Steel Rolls
Carbon and Alloy Steel Castings

for AHEAD-OF-THE-FIELD engineering

REHEATING
FURNACE EQUIPMENT
by Continental



FURNACE RUN-IN TABLES
FURNACE RUN-OUT TABLES
FURNACE PUSHERS
FURNACE BUMPERS
FURNACE DEPILERS

Continental

check first with

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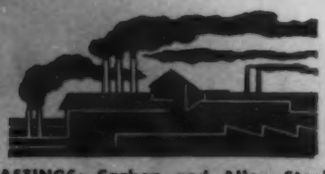
FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

PLANTS AT:

EAST CHICAGO, IND.; WHEELING, W. VA.; PITTSBURGH, PA.



CASTINGS: Carbon and Alloy Steel; from 20 to 250,000 Pounds.

ROLLS: Iron, Alloy Iron and Steel; for All Types of Rolling Mills.

MILLS: Complete Installations of Rolling Mills and Auxiliary Equipment.

Up to 22 times more operations without re-lubricating

HOMESTEAD-REISER

Self-Seald

LUBRICATED PLUG

VALVES

TEST RECORD

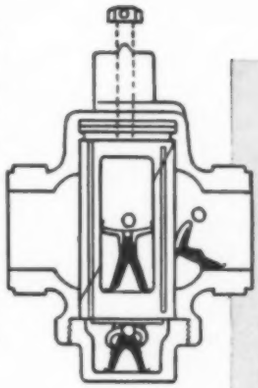
VALVE	NO. OF OPERATIONS Without RE-LUBRICATING
VALVE "A"	5
VALVE "B"	33
HOMESTEAD-REISER VALVE	**110**

Each valve assembled with the manufacturer's recommended lubricant. Test made on 75 lb. air pressure.

This comparative test of a Homestead-Reiser Valve and two other well-known lubricated plug valves showed that the Homestead-Reiser Valve remained drop-tight through twenty-two times more operations than Valve "A" without re-lubricating, and through three times as many operations as Valve "B". That means that Homestead-Reisers require less attention, and give greater economy of lubricant.

Prove the superiority of Homestead-Reiser Valves to your own satisfaction, by installing a few in your plant, side by side with any other lubricated plug valve. They may be had in both semi-steel and cast-steel, sizes ½" to 12" for steam working pressures to 150 pounds, or oil-water-gas to 200 pounds.

Write for new catalog 39-5, and for prices on your requirements.



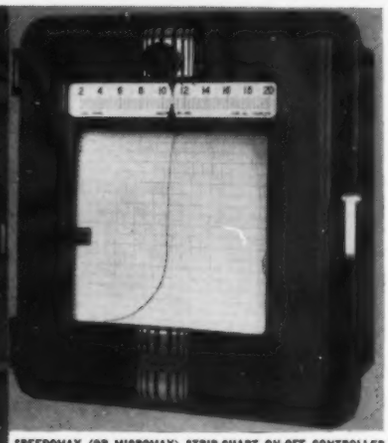
"Self-Seald" MEANS

. . . that in addition to a full-port lubricant seal, the wedge-action of the plug under line pressure forces the finished surfaces of the plug outward, and constantly presses them against the seating surfaces of the body, thus keeping them always in intimate contact. The plug automatically adjusts itself for wear, assuring extra long life, maximum leakless service, and lubricant economy.

HOMESTEAD VALVE MANUFACTURING CO.

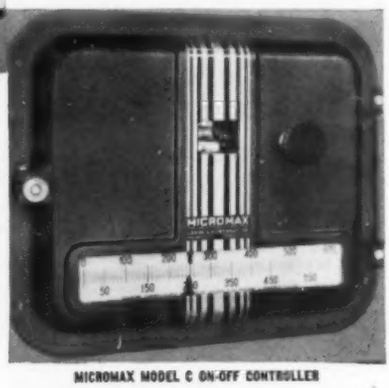
"Serving Since 1892"

P. O. Box 21 **CORAOPOLIS, PA.**



SPEEDOMAX (OR MICROMAX) STRIP-CHART ON-OFF CONTROLLER

SPEEDOMAX ROUND-CHART ON-OFF CONTROLLER



MICROMAX MODEL C ON-OFF CONTROLLER

ELECTROMAX ON-OFF CONTROLLER

Dependable "ON-OFF" Controllers for Industry

THE kind of control instrument which industry calls on-off or 2-position is not only the oldest form of automatic regulator, but is one which many manufacturers still use, instead of more advanced types, for simple requirements. Usually, the instrument merely closes the valve when temperature reaches the control point, and opens valve again when temperature falls below point. The question of whether such on-off action is best for the given case can of course be settled by using the instrument with the best, most useful features. Here are some which L&N On-Off Controllers offer:

1. Instruments may be Recording Controllers with either strip-chart or round-chart, or Controllers with no charts at all.
2. Instruments can operate at high or moderate speed; can be located regardless of machine vibration, building tremors or distance from process.
3. Controls are outstandingly dependable because they "balance" temperature against a standard. Intermediate bearings and springs cannot increase, decrease or otherwise influence accuracy or sensitivity.
4. Low maintenance assured by machine-like design and construction.
5. More than 1000 standard ranges. Specials are available, but seldom needed.

Tell us your problem and we will send further information. Write either to our nearest office or to 4942 Stenton Avenue, Philadelphia 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

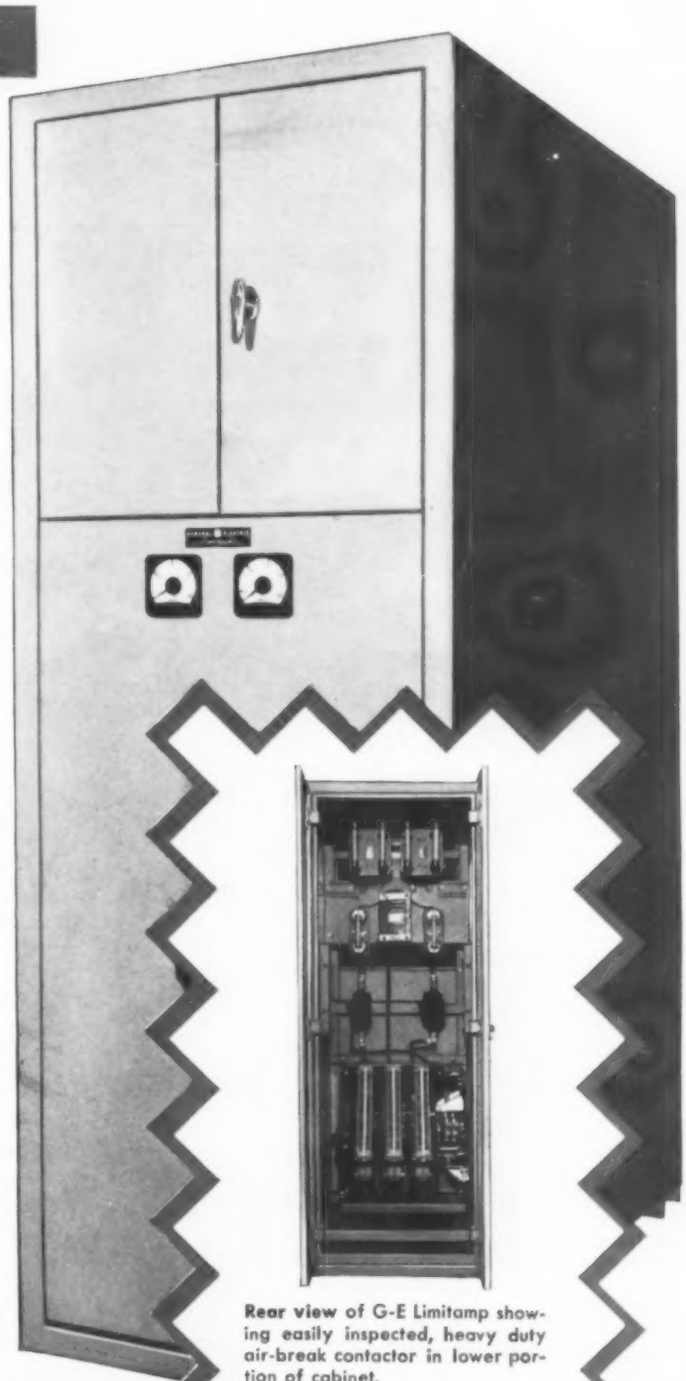
THESE instruments are fully automatic; need no standardizing; are ideal even for hard-to-get-at or difficult locations.

Jrl. Ad ND4-33(3)

NOW! FOR THE FIRST TIME

for motors up to 2250 hp*

LIMITAMP HIGH-VOLTAGE CONTROL



This G-E Limitamp motor controller with a new 400-amp air-break contactor is pre-engineered, factory assembled and tested—with all the control and motor protection you need in one steel enclosure.

Current-limiting EJ-2 fuses provide short-circuit capacity up to 250,000 kva. Air-break contactors are good for millions of operations with only routine maintenance, so Limitamp control is recommended especially for motors on severe duty cycles. Low first cost (only $5830** for 2250-hp synchronous motor control) as well as continuing savings because of low operating and servicing costs, make this an economical buy.

Available for 2300-volt motors up to 1250 hp, and 4800-volt motors up to 2250 hp. Ask your nearest G-E sales engineer for more information on the new 400-amp size, or write for Bulletin GEA-5409 for details on G-E Limitamp control. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

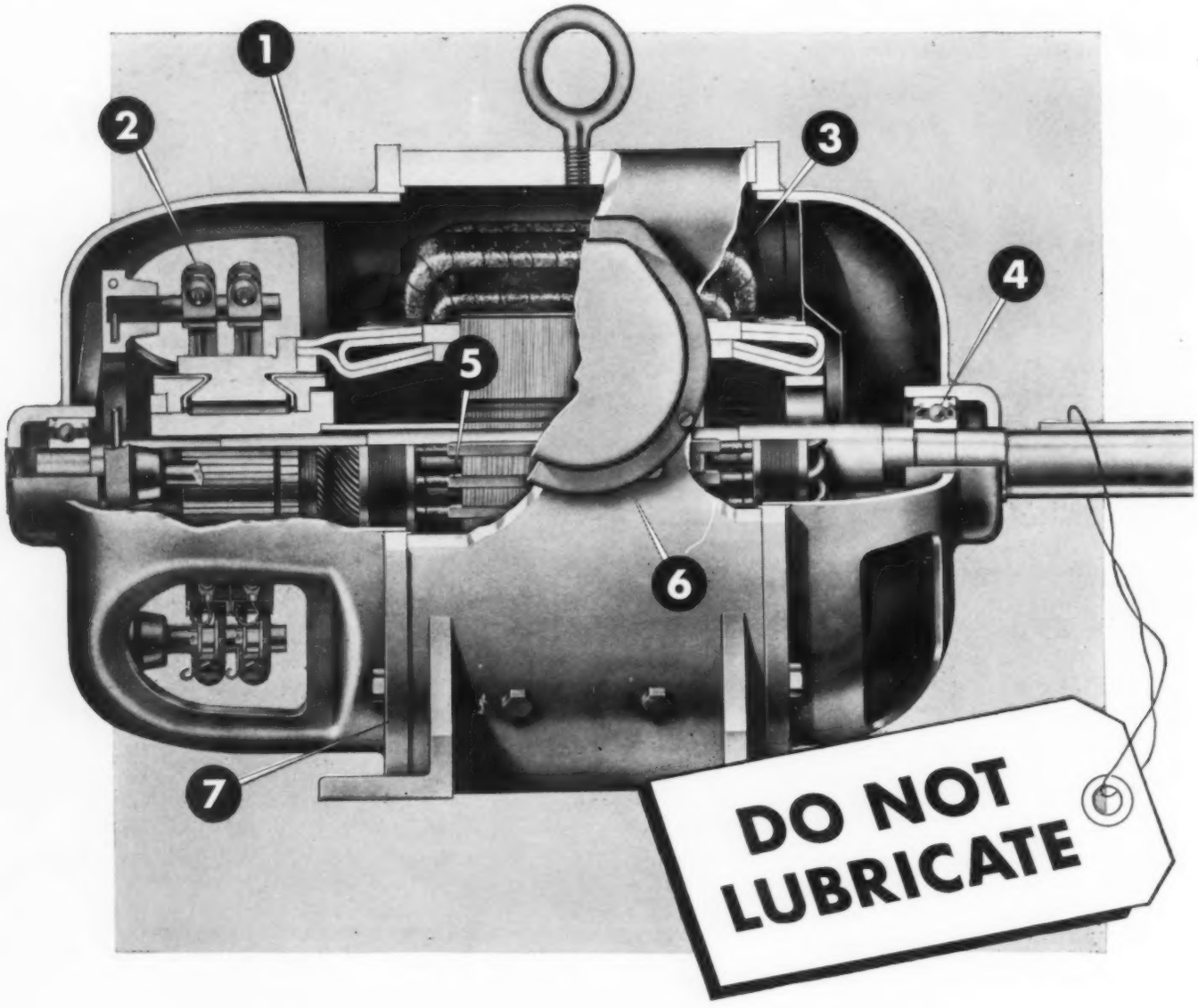
*2500 hp for 1.0 pf synchronous motors.
**List price. Subject to change without notice.

Rear view of G-E Limitamp showing easily inspected, heavy duty air-break contactor in lower portion of cabinet.

GENERAL ELECTRIC

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



1. ALL-STEEL BRACKETS
2. INDIVIDUALLY REMOVED CAST BRASS BRUSHHOLDERS
3. SHELL-WOUND FIELD COILS
4. DOUBLE-SEALED PRE-LUBRICATED BALL BEARINGS
5. HEAVY-DUTY PRESHAPED ARMATURE COILS
6. STEEL-GASKETED CONDUIT BOX
7. ROLLED-STEEL FRAME

If you figure LIFE-COSTS . . . you'll figure LIFE-LINE

SK DEPENDABILITY
Wrapped in Steel
in the NEW Life-Line D-C MOTOR

Thirty-nine years at hard labor—in steel mills . . . in mines . . . in a thousand and one applications—have proved the dependability of the type SK d-c motor. Now, new dependability has been added—new motor stamina . . . new freedom from maintenance . . . new value for d-c motor users.

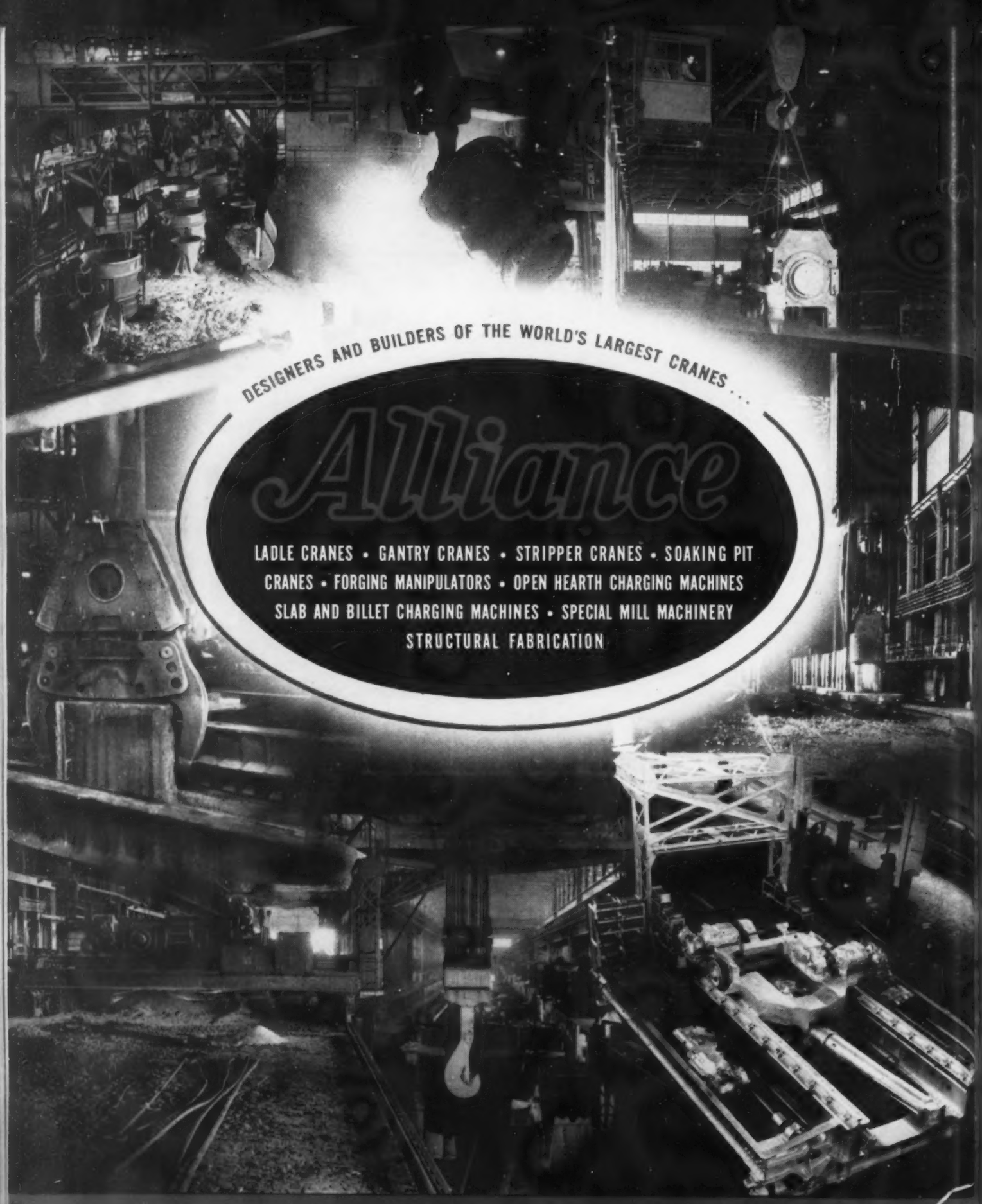
MAXIMUM STRENGTH AND RIGIDITY—Heavy steel end brackets and rolled-steel frame stand up to the shocking, jarring blows so often encountered in rugged d-c service.

SIMPLIFIED SERVICING—Readily accessible through spacious opening in front bracket, brushholders may be removed individually. Armature coils, wound from Tufvar wire and treated in Thermoset varnish assure long life . . . reduce trouble from shorts and grounds. Double-sealed pre-lubricated bearings (proved in over half a million motors) put an end to greasing problems.

INDIVIDUAL FIELD COIL UNITS—One coil may be replaced without expense of replacing all . . . or discarding pole piece. Just slip the new coil in place . . . save repair costs.

These are a few highlights of the new, all-steel Life-Line type SK d-c motor. Get the complete facts on series, shunt, or compound motors . . . frames 203-365 . . . in 1 to 30 hp ratings. Contact your local Westinghouse representative. Ask for a copy of "D-C Motor" Booklet B-4595, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21549

Westinghouse
Life-Line
D-C Motors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LADLE CRANES • GANTRY CRANES • STRIPPER CRANES • SOAKING PIT CRANES • FORGING MANIPULATORS • OPEN HEARTH CHARGING MACHINES SLAB AND BILLET CHARGING MACHINES • SPECIAL MILL MACHINERY STRUCTURAL FABRICATION

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The Books Don't Tell All...

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NEW CONCEPT OF HEAT PROCESSING IS CHANGING PRODUCTS AND METHODS

It takes more than ordinary armor plate to stop the new bazookas . . . it took new engineering and metallurgy to withstand the heat of "jets." Industrial and military demands are moving ahead so rapidly, products and production methods are changing . . . changing so rapidly, the books don't have all of the answers—can't have all the answers.

Heat processing is a striking example. Selas Engineers found their own answers to better products and methods . . . their engineering far-sightedness developed a new concept of heat processing . . . GRADIATION. A departure from ordinary heating methods . . . it is radiant heat used as a precision tool. Gradiation combines high-temperature radiant gas heat, high-speed automatic operation, precise controllability and protective atmosphere.

Gradiation with its precision radiant heat, has proved its value in better quality and increased production of metals in annealing, hardening, drawing, forging, bending, or reheating. Wherever heating is used in working with metals, Selas Gradiation has improved methods and product quality . . . established new high production rates.

If you use heat in processing, you can use the developments of Selas Gradiation . . . and you will be interested in getting more data from our Engineering Department.

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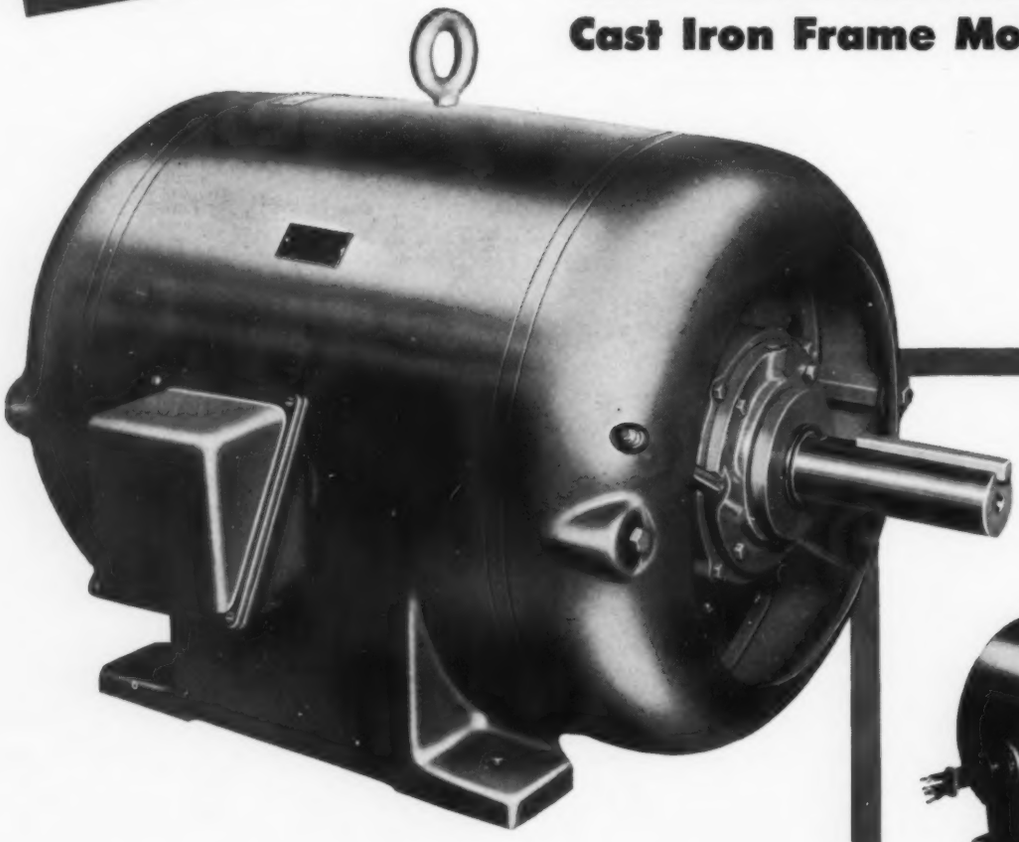
Wagner
ELECTRIC MOTORS
...the choice of leaders in industry

corrosion is no problem—

WHEN YOU USE

Wagner

Cast Iron Frame Motors



Rugged, one piece, corrosion-resistant, cast iron inner and outer frame, showing openings for ventilation.

They resist the damaging action of acids, fumes, moisture and other destructive elements

Wherever corrosion resistance is a "must" for motors—in chemical plants, oil fields, refineries, and industrial plants where tough operating conditions exist—Wagner Cast Iron Frame Motors are a sound choice.

They feature special varnish treated windings that resist acids and alkalies . . . a cast iron, gasket-sealed conduit box . . . and drain plugs in the endplates for easy removal of condensation from inside the motor. They are totally enclosed in rust and corrosion-resistant cast iron—even the nameplate is made of corrosion resistant material!

Wagner Cast Iron Frame Motors are available in ratings from 5 to 250 horsepower, in both standard totally-enclosed fan-cooled and explosion-proof designs.

Bulletins give full information on these, and other motors in Wagner's complete line. Thirty-one branch offices, located in principal cities, are ready to assist you in any motor application problem.

Wagner Electric Corporation
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BRANCHES IN 31 PRINCIPAL CITIES

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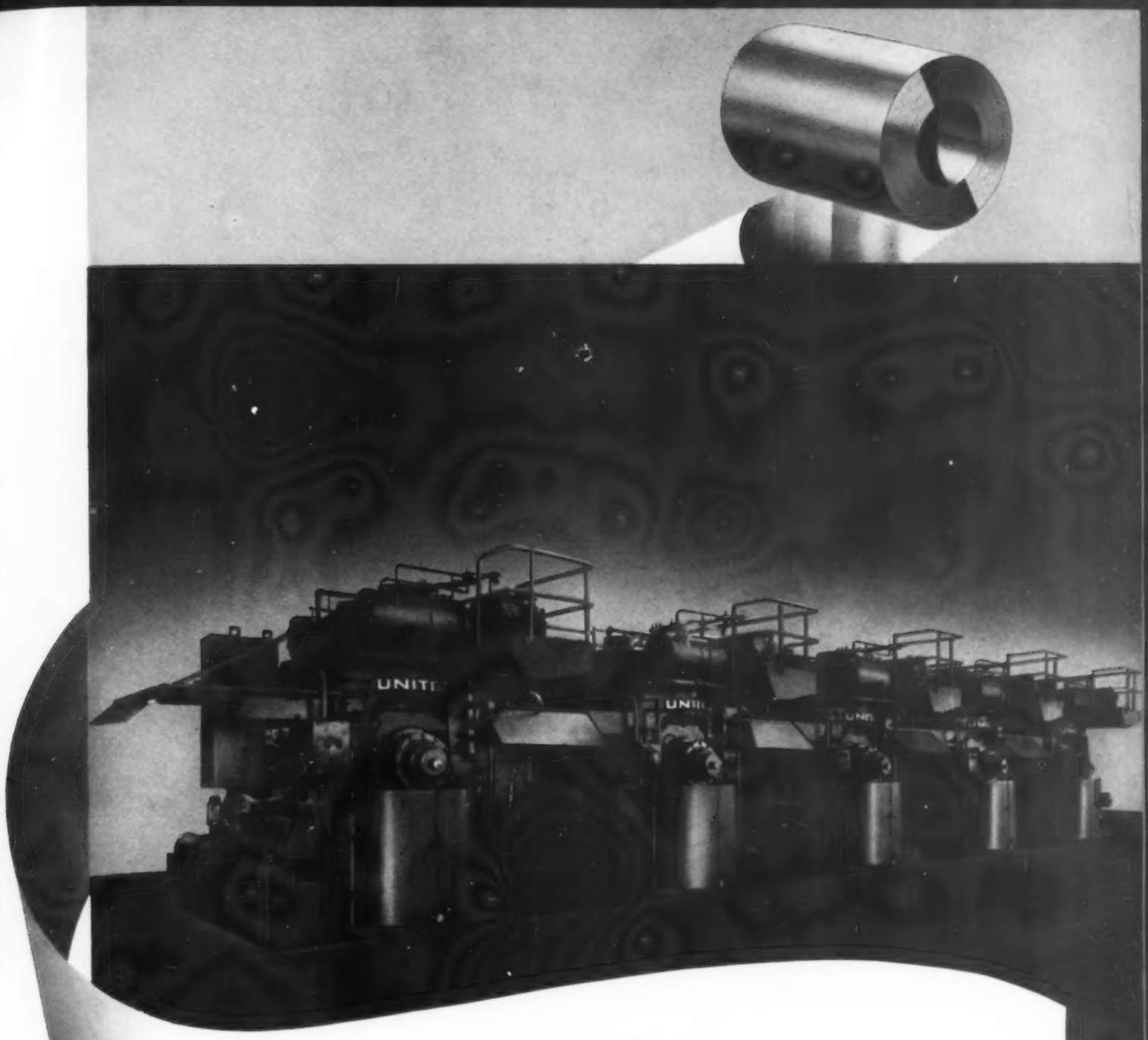

UNITED

5-stand Tandem 4-high Cold Mill

UNITED ENGINEERING AND FOUNDRY COMPANY

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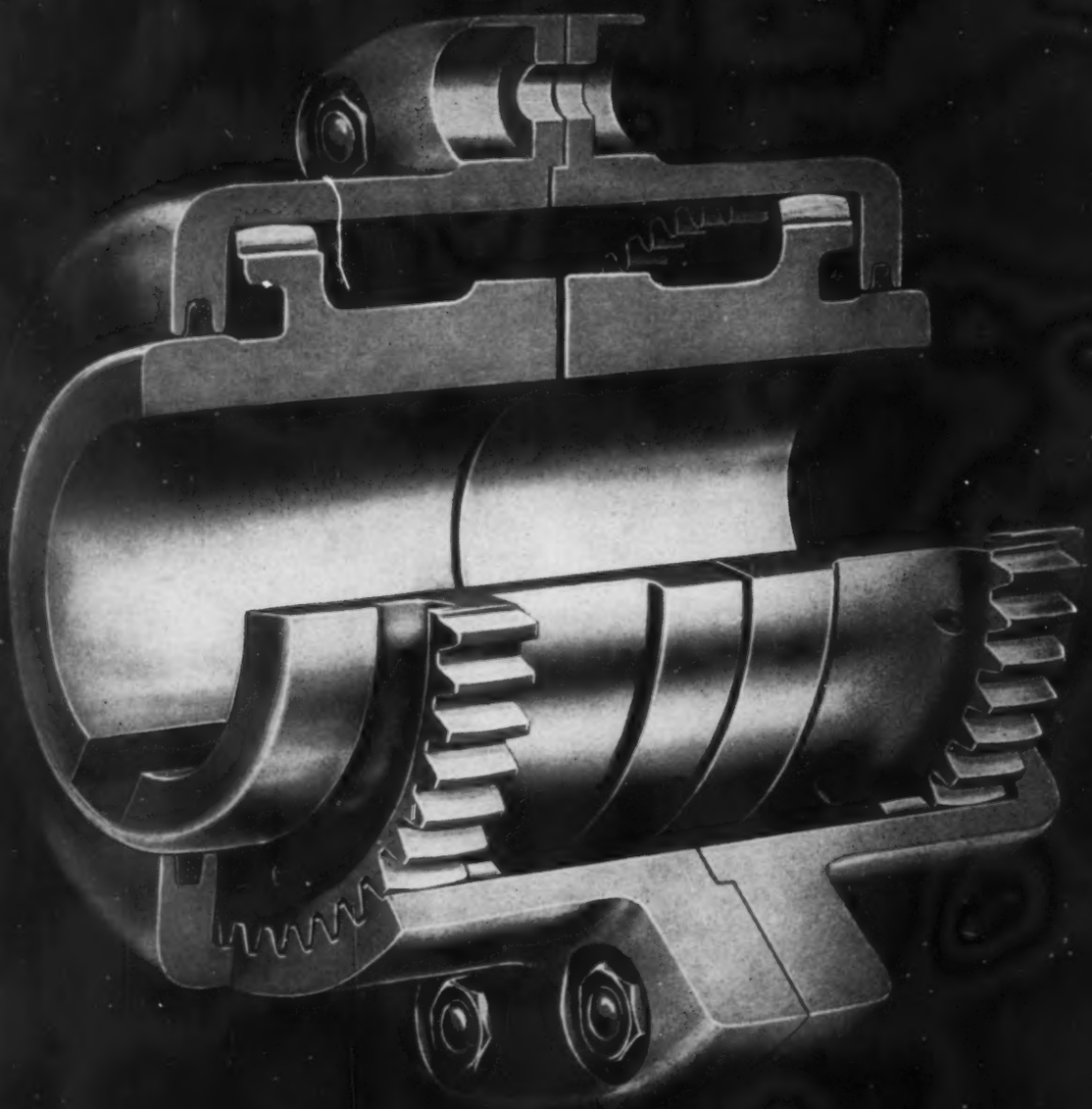

A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

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POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

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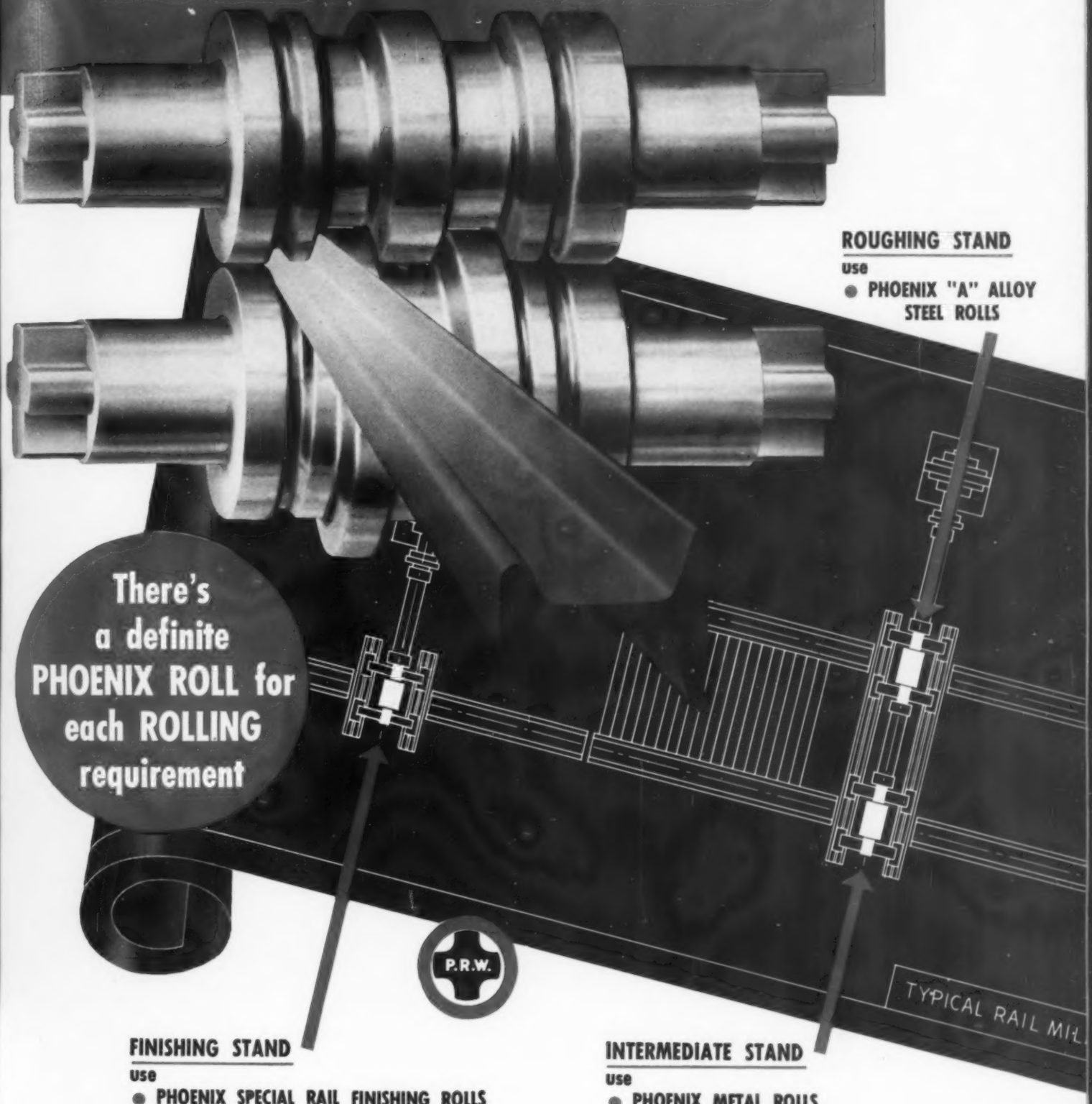

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PITTSBURGH ROLLS DIVISION OF BLAW-KNOX COMPANY • PITTSBURGH, PA.

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Recirculating Radiant Tube

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One of many fine-performance features: the unique Swindell-Dressler *high velocity* burner, which gives better, more uniform distribution of heat in the tube . . . and very exceptional tube life with coke oven gases (2 to 3 times normal). *May we consult on your needs?*

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FORD MOTOR COMPANY*	River Rouge, Mich.	1925
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AMERICAN STEEL & WIRE CO.	Worcester, Mass.	1926
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JOHN A. ROEBLING'S SONS CO.	Trenton, N. J.	1927
SHEFFIELD STEEL CORPORATION	Kansas City, Mo.	1928
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FRIEDRICH KRUPP, A. G.***	Rheinhausen, Germany	1929
FRIEDRICH KRUPP, A. G.*	Rheinhausen, Germany	1929
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AUSTRALIAN IRON & STEEL, LTD.*	Port Kembla, Australia	1936
YOUNGSTOWN SHEET & TUBE CO.***	Youngstown, Ohio	1940
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CONSETT IRON COMPANY, LTD.***	Consett, England	1950

*Mill also rolls sheet bar
**Mill also rolls sheet bar and skelp
***Mill also rolls slabs

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Rolling Mills - Morgoil Bearings - Wire Mills
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RM-34

...always a fast, even heat
...like INTERNATIONAL GRAPHITE ELECTRODES

International GRAPHITE AND ELECTRODE CORP.
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6261

Better lubrication, lower maintenance costs for roll neck bearings —

Gulf XXX Lubricant

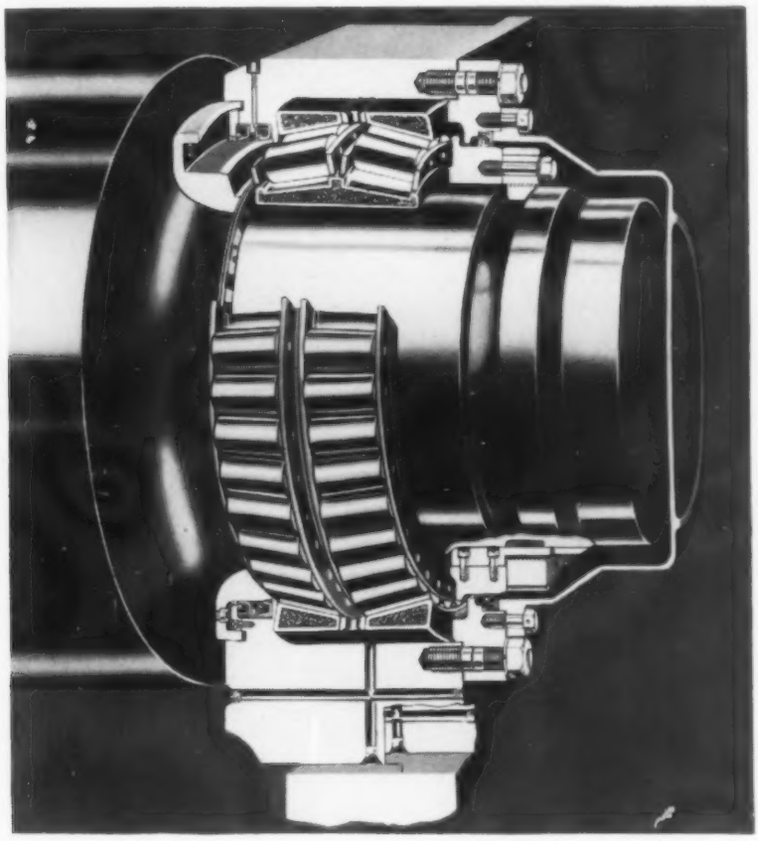

Photo courtesy The Timken Roller Bearing Company.

- X Exceptional extreme pressure characteristics
- X High resistance to washout
- X Effective protection against corrosion
- X Good stability
- X High pumpability

Gulf XXX Lubricant provides the kind of lubrication that insures long life and low maintenance costs for roll neck roller bearings. Here's why! Gulf XXX Lubricant is a high quality grease that has exceptionally good extreme pressure characteristics—protects rollers and races subjected to shock loads or overloads. It provides that extra margin of protection so often required in rolling mill service.

Gulf XXX Lubricant stays put—is not washed out of the bearing, even when subjected to the washing action of large quantities of water. Thus bearings get continuous protection and grease consumption is kept to a minimum.

Another advantage of Gulf XXX Lubricant under wet conditions is its excellent rust-preventive characteristics — it covers every roller and raceway with a film that protects highly polished surfaces. You will eliminate bearing failures from this cause when Gulf XXX Lubricant is in use.

Then, too, Gulf XXX Lubricant is a very stable grease—won't separate in storage or in service. It has excellent pumpability and is ideal for centralized lubricating systems.

For further information on Gulf XXX Lubricant and other Gulf quality lubricants for steel mills, call in a Gulf Lubrication Engineer today. Write, wire, or phone your nearest Gulf office. Gulf Oil Corporation · Gulf Refining Company, Gulf Building, Pittsburgh, Pennsylvania.

FIFTY YEARS OF SERVICE
1901 GULF 1951
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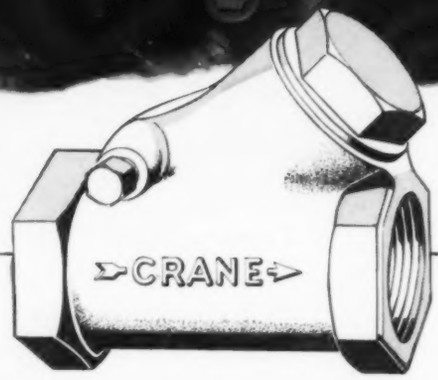
More **CRANE VALVES** are used than any other make

Crane "Pulsator" test of check valve endurance. By continuous sudden reversals of air pressure, valve discs are slammed open and shut at rates up to several hundred cycles per minute.

How Many Checks in a Good Check Valve?

You don't buy them that way, but that's what finally determines the value of check valves in your pipe lines. That's why Crane is so completely equipped for accurately pre-testing valve performance. For instance, "wearability" of check valves is tested by opening and closing the valves continuously on various fluids under conditions of actual service. Special equipment is used to accelerate these tests to equal many years' service in a short period. Countless tests like this—of materials, designs, and finished products—insure the superior performance values that mean lower piping costs for users of all Crane valves and fittings.



This new regrinding Brass Swing Check design typifies Crane's continuing product development for better valve performance, lower piping maintenance costs. For increased flow capacity . . . for fast, positive closure on backflow . . . for easier servicing without removing valve from line . . . get a demonstration of these 200 and 300-Pound Y-Pattern Check Valves. Phone your Crane Representative, or ask for literature.

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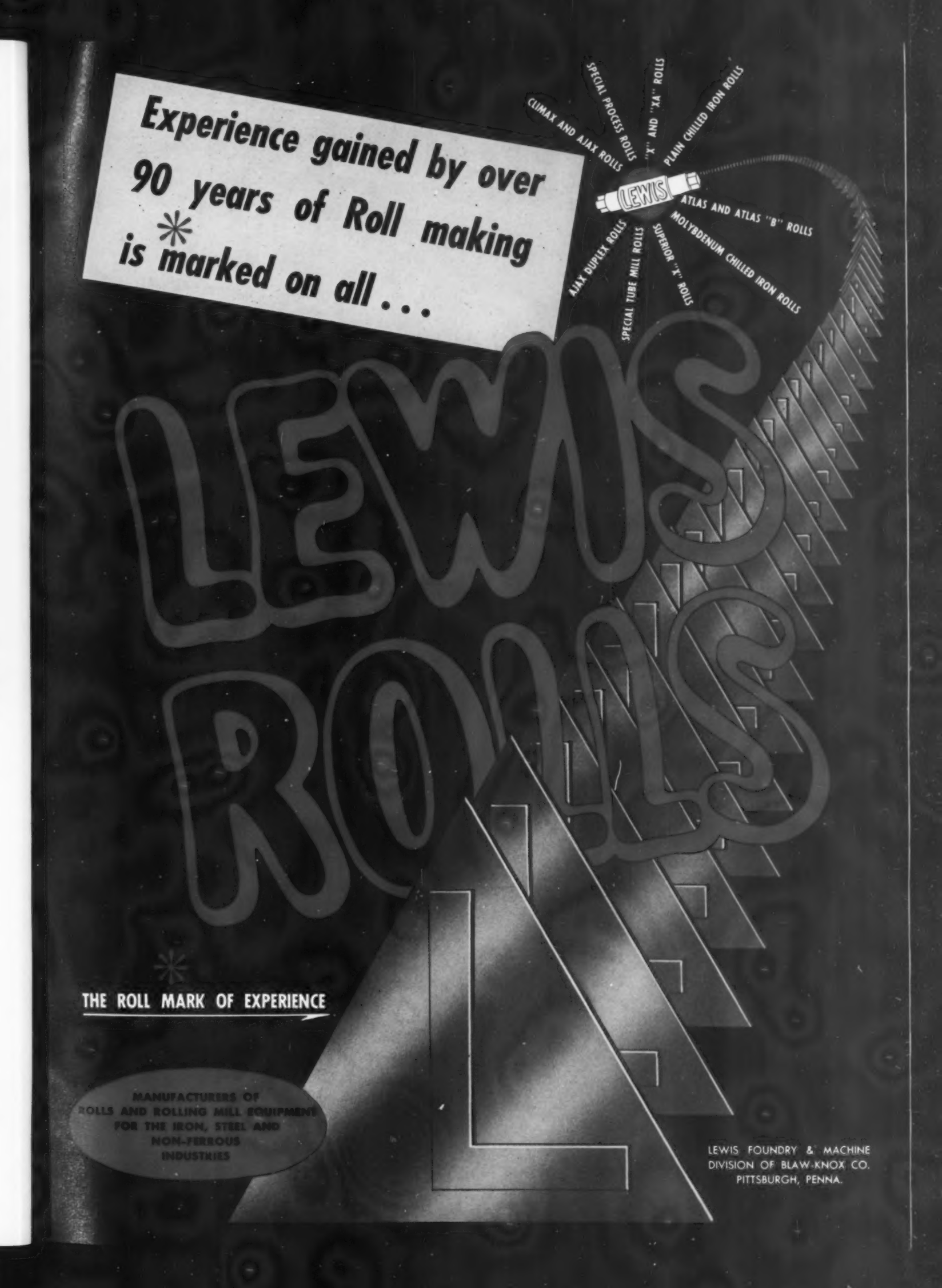
VALVES • FITTINGS • PIPE • PLUMBING • HEATING


Experience gained by over 90 years of Roll making is marked on all...
SPECIAL PROCESS ROLLS
"X" AND "XA" ROLLS
PLAIN CHILLED IRON ROLLS
CLIMAX AND AJAX ROLLS
LEWIS
ATLAS AND ATLAS "B" ROLLS
MOLYBDENUM CHILLED IRON ROLLS
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SPECIAL TUBE MILL ROLLS
SUPERIOR "X" ROLLS
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THE ROLL MARK OF EXPERIENCE
MANUFACTURERS OF ROLLS AND ROLLING MILL EQUIPMENT FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES
LEWIS FOUNDRY & MACHINE DIVISION OF BLAW-KNOX CO. PITTSBURGH, PENNA.

CONDULETS* and rigid conduit

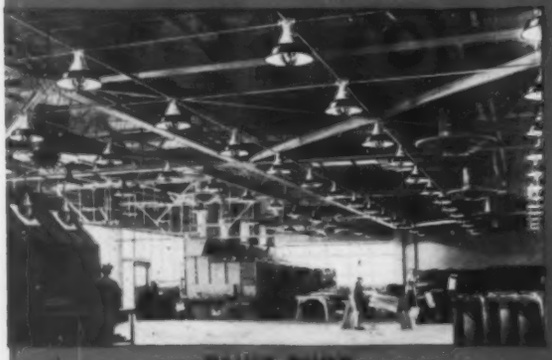
YOU can install galvanized CONDULETS and galvanized rigid conduit under all atmospheric conditions and in all occupancies

(See Article 346, Section 3462, National Electrical Code.)

PETROLEUM REFINERY

STOCK ROOM

GRINDING ROOM



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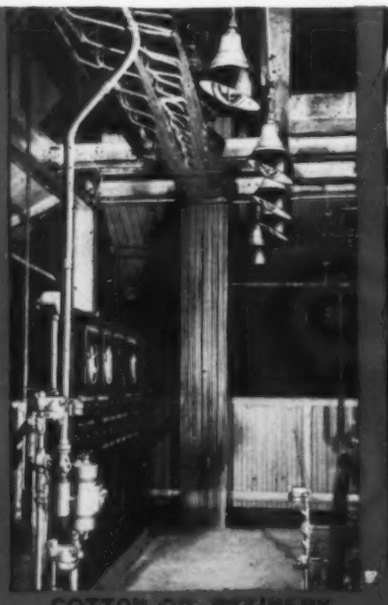
The **CONDULET** and rigid conduit method meets the requirements of the National Electrical Code in locations exposed to weather, heat, moisture, steam, vapor, dust and dirt or locations that are hazardous because of the possibility of the presence of flammable gases or vapors, or combustible dusts. The same sterling qualities that make **CONDULETS** the first choice in these special applications, make them first choice in ALL ordinary locations.

**CONDULET* is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.*



COTTON OIL REFINERY

CHEMICAL PLANT

....the UNIVERSAL wiring method

"for MODERN WIRING . . .

the CONDULET and conduit method

gives you definite advantages"

1. **MECHANICAL PROTECTION . . .** Rigid conduit and cast Feraloy CONDULETS provide the best possible protection against accidental damage to the wiring and equipment. Prevents costly shutdowns.

2. **SAFETY . . .** A CONDULET installation gives maximum protection against personal injury and fire. The continuous conduit system made up with taper threaded CONDULETS provides a reliable and permanent low resistance path to ground.

3. **FLEXIBILITY . . .** To meet all the diverse requirements of modern electrical layouts, CONDULETS are made in a wide variety of shapes and sizes with varied hub arrangements, including a full line of CONDULETS with detachable hub plates.

4. **ECONOMY . . .** The installed cost compares favorably with other methods, while the total cost over the years is definitely lower, due to the durability, reliability, safety, and low maintenance cost of a CONDULET and rigid conduit system.

5. **CORROSION RESISTING . . .** Galvanized cast Feraloy CONDULETS offer the best protection wherever moisture, dust or corrosive atmospheres are present.

6. **QUALITY . . .** The trademark CONDULET stands for reliability and long life. Every CONDULET is built to Crouse-Hinds high standard of quality with painstaking care by skilled craftsmen.

On **YOUR** next electrical layout, for any location, plan to get all the benefits of sturdy cast Feraloy CONDULETS and rigid conduit . . . the UNIVERSAL wiring method. More than 15000 types and sizes are listed in the CONDULET Catalog.

CROUSE-HINDS COMPANY

Syracuse 1, N. Y.

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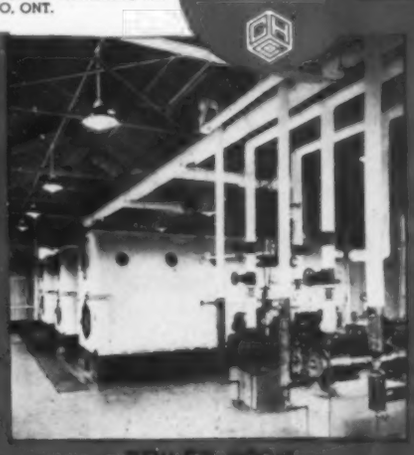
TEXTILE MILL

GRAIN MILL

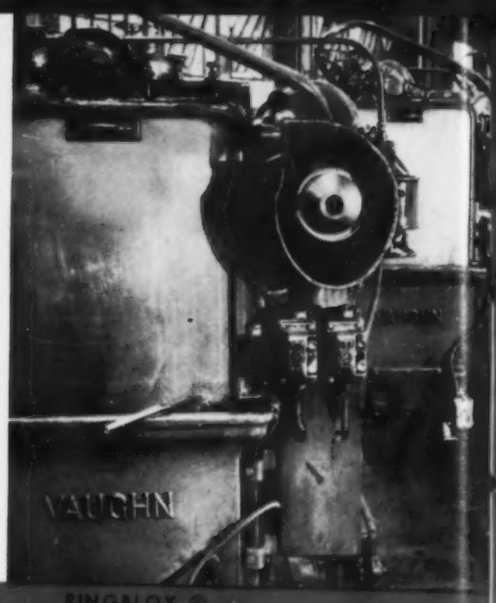


BOILER ROOM

STEEL MILL

MOTOBLOC ®

MOTOBLOX ®



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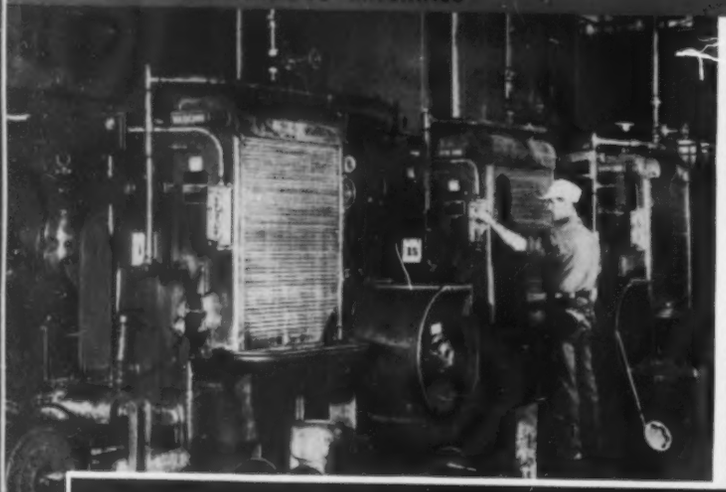
Leading the way—

TO PROFIT ON ALL COLD DRAWING JOBS!

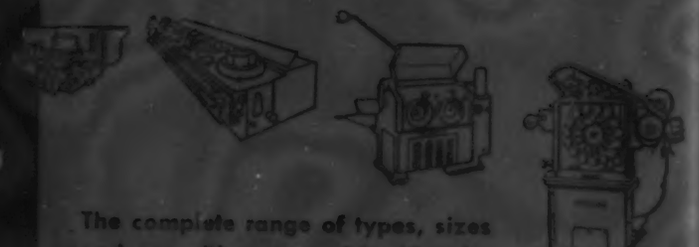
CONTINUOUS MACHINES



DRAW BENCHES

Vaughn®

COLD DRAWING MACHINERY



The complete range of types, sizes and capacities covered by Vaughn Cold Drawing Machinery provides the most efficient answer for each of your cold drawing requirements. • May we arrange for a practical discussion of your needs?

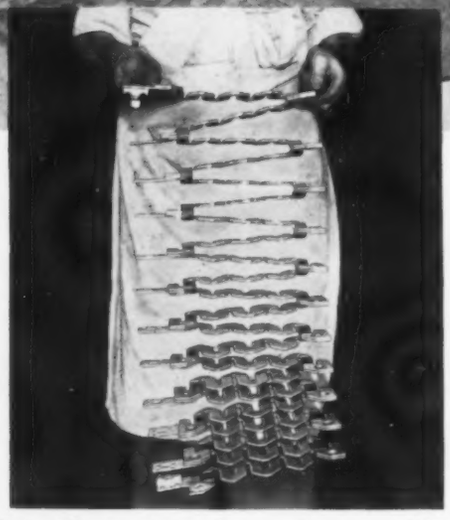
"Quick on the Draw!"
VAUGHN MACHINERY
PROFITABLY USED BY LEADING WIRE MILLS SINCE 1871

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U.S.A.

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

Simplified TAP Shifting

1. When Improving Motor Operation
2. Making it Easier to replace Sections
TAB WELD
PLATE RESISTOR
THE ELECTRIC CONTROLLER & MFG. CO.



This illustration shows how welding provides a continuous path throughout each section to:

1. Stabilize the resistance value.

2. Eliminate trouble in concealed areas.

EC&M TAB-WELD Resistors do *not* depend upon *occasional* tightening of end-clamping nuts *to prevent burning at grid-eyes or at tap-plates.*

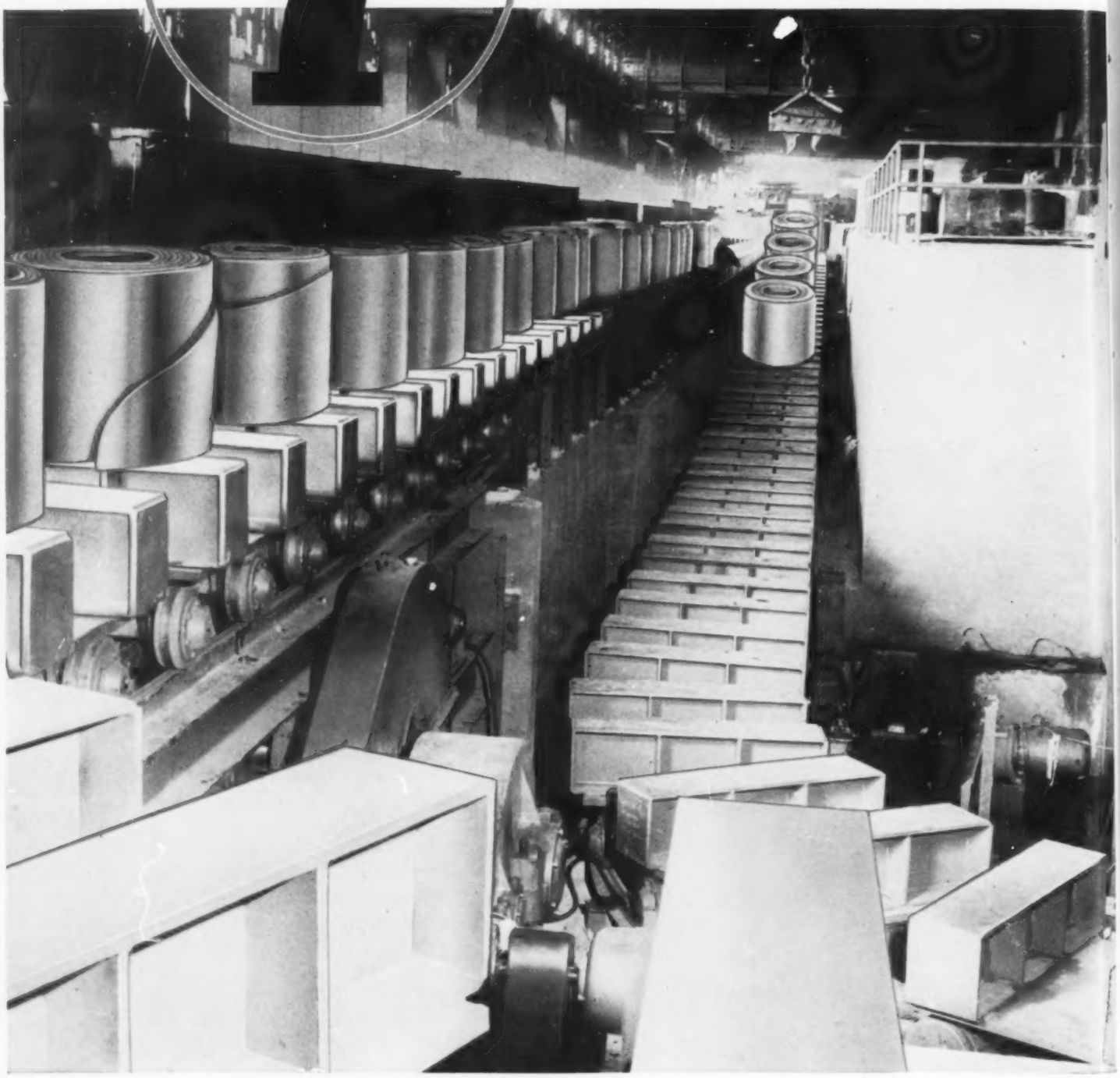
★ It's often advantageous to shift taps on a resistor section after installation to improve motor performance. It's equally advantageous, when replacing a section out in the mill, to pick a standard section from the storeroom shelf and use it *without disturbing the grid-assembly*.

These operations are easy to perform with EC&M TAB-WELD Resistor Sections because tap-plates are fixed in position. Only the terminal block, bolt, and lead are moved. The tap-marking tag moves with the bolt.

For lower up-keep, prolonged life, and easier maintenance, use EC&M Bulletin 942 TAB-WELD Plate Resistors, made from *corrosion-resistant* steel.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

7 WAYS TO

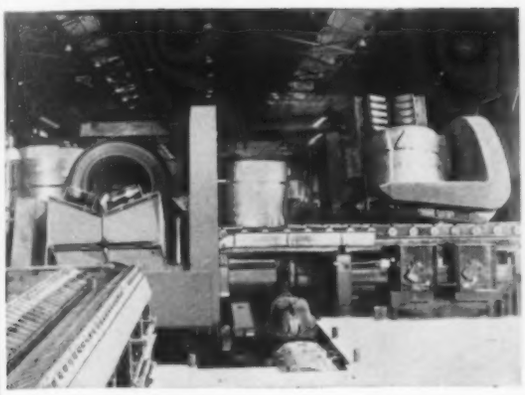


1 Along every step of the way—in every process—Link-Belt can help you cut costs with modern materials handling machinery. See a typical example, above. Here, Link-Belt Car-Type Conveyors economically move coils of hot strip around corners and down inclines—all without rolling or scuffing edges.

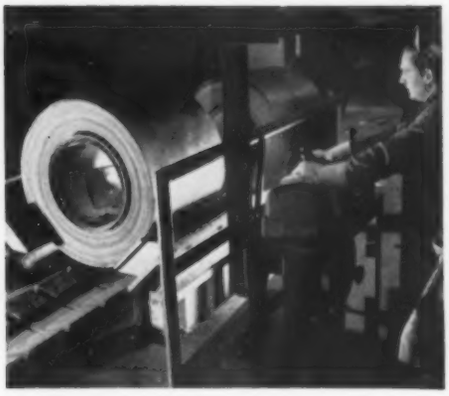
Link-Belt is materials handling headquarters. Working hand-in-hand with your own engineers, consultants, and builders of mill and process equipment, Link-Belt engineers can help you solve your mechanization problems. Write direct or contact your nearest Link-Belt representative.

GREATER YIELD

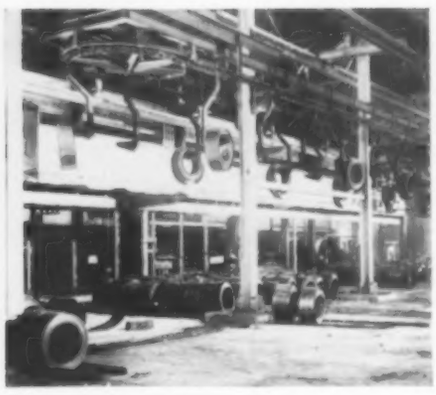
LINK-BELT can help you increase output in your present plant with modern mechanization



2 Greater yield comes from gentler handling. Link-Belt Down-Tilters and Transfers are designed to provide smooth, controlled manipulation of hot coils and increase mill yield by reducing scrap.



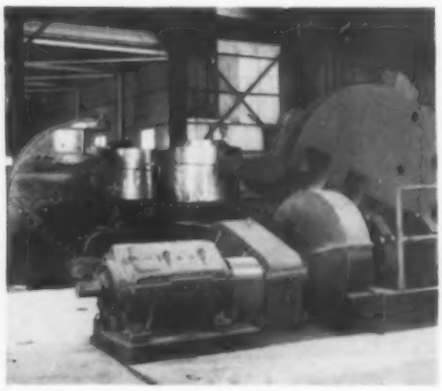
3 Link-Belt Conveyors provide controlled storage ahead of pickle lines, cold mills and other processes. This is essential for scheduling and to eliminate the confusion of vehicles and the hazard of overhead cranes.



4 Link-Belt Overhead Trolley Conveyors create added work-area on floors of existing plants — are readily adaptable to irregular paths and building structures for carrying and cooling coils of narrow strip, rod and wire.

5 Link-Belt can step up your raw materials storage and handling operations — permit the storing of more materials in the same area ... storing at higher tonnage rates ... reclaiming at increased handling rates.

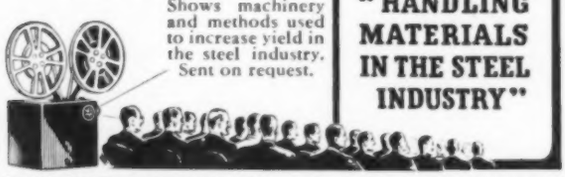
6 Specially developed Link-Belt Chains take brutal punishment year after year in the nation's steel mills. Standard types are available for basic elements of complete handling systems or power transmission.



7 Link-Belt Herringbone Gear Drives are engineered to take heavy shock loads dependably and continuously. Yes — wherever power is to be transmitted mechanically, Link-Belt offers a full range of gear and chain drives.

30 MINUTE COLOR-SOUND FILM AVAILABLE

Shows machinery and methods used to increase yield in the steel industry. Sent on request.



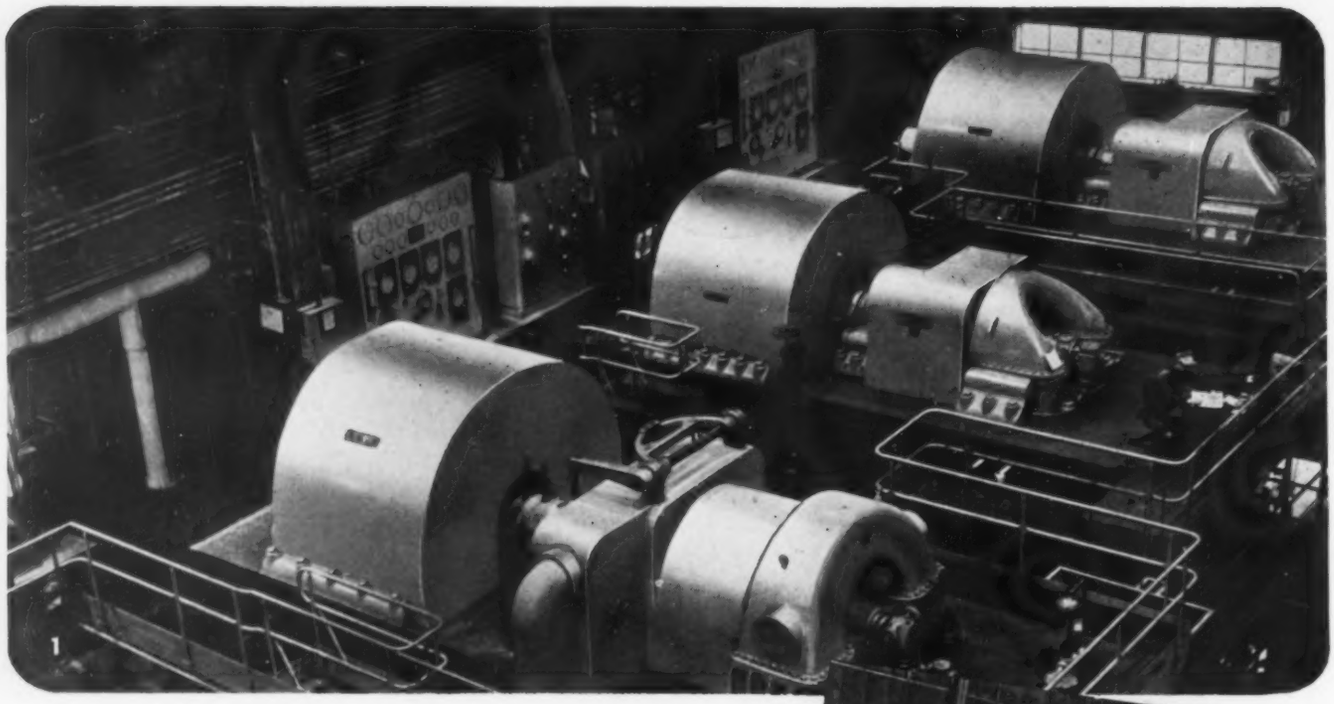
"HANDLING MATERIALS IN THE STEEL INDUSTRY"

12,208

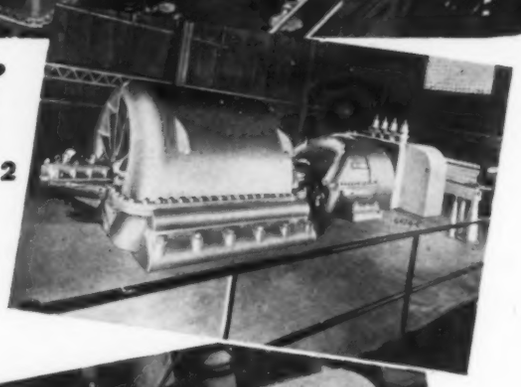
LINK-BELT

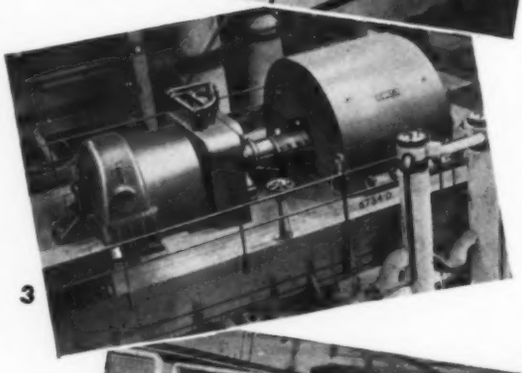
Materials Handling, Processing and Power Transmission Machinery

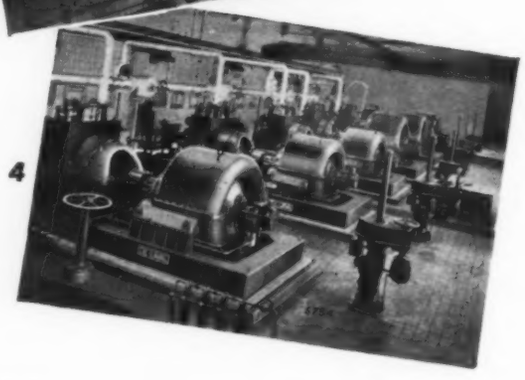
LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Cleveland 15, Pittsburgh 13, Atlanta, Dallas 1, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.



DE LAVAL BLOWERS SERVE AMERICA'S LEADING STEEL PRODUCERS







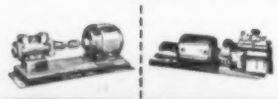
Carnegie-Illinois, Jones & Laughlin, Pittsburgh Coke & Chemical, Wheeling Steel, Great Lakes Steel, Pittsburgh Steel, Lone Star Steel, Steel Company of Canada, Canadian Furnaces, Ltd. and others—all use De Laval blowers.

1. **At the Edgar Thomson Works** of the Carnegie-Illinois Steel Corp. The most recent of three De Laval turbine-driven blowers is the unit in the foreground. This blower is rated at 123,000 cfm at 33.3 psig (equivalent at standard conditions) and is driven by a 13,900 hp turbine designed for operation at 650 psig.

2. **At the Aliquippa Works** of the Jones & Laughlin Steel Corp. One of two De Laval 100,000 cfm blowers driven by an 11,110 hp De Laval turbine.

3. **At the Gary Steel Works** of the Carnegie-Illinois Steel Corp. One of three 110,000 cfm De Laval blowers driven by a 12,350 hp De Laval turbine.

4. **Six more De Laval turbine-driven blowers** at Aliquippa Works of the Jones & Laughlin Steel Corp.



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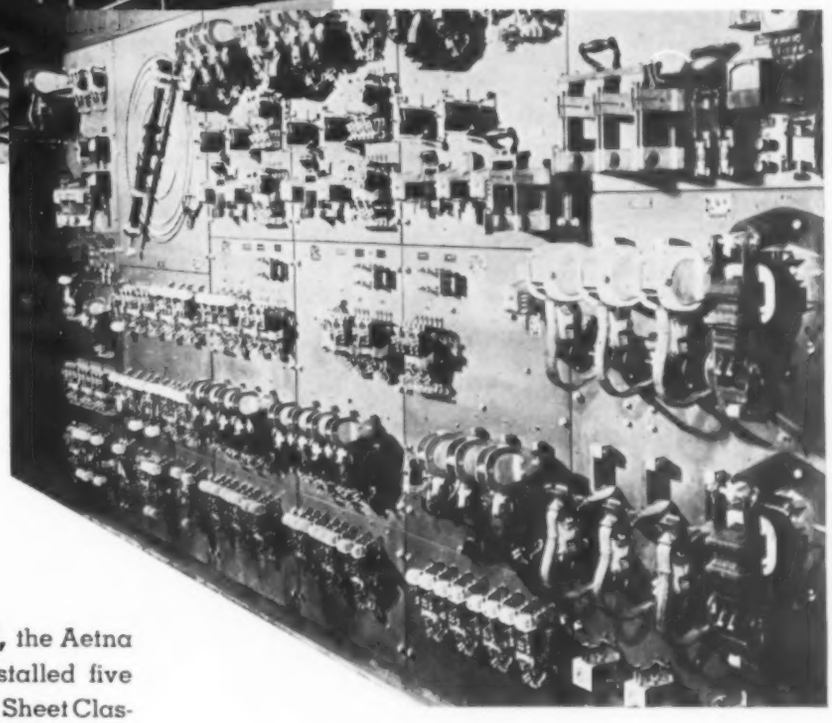
DE LAVAL STEAM TURBINE CO. Trenton 2, N. J.

C-13

CLARK CONTROL for HIGH SPEED TIN MILL SHEARING LINE

5 Aetna-Standard Shearing Lines



Clark DC Control for One Shearing Line

● ***In a Midwest Tin Plate Mill,*** the Aetna Standard Engineering Company installed five Flying Shear Lines with Side Trimmer, Sheet Classifiers and Conveyors, **ALL CLARK CONTROLLED.**

These lines handle coils up to a maximum of 30,000 pounds, and are capable of operating up to a maximum speed of 1000 feet per minute.

To maintain this high speed, the **CLARK** mill type apparatus ably co-operates to control the many motors that drive the heavy duty lines.

The build-down of the Payoff and the Speed-match, between the Side Trimmer and Shear, are automatically controlled by **CLARK** Photo-Electric Modulated Loop Control.

This is a typical **CLARK ENGINEERED** installation, accurately and efficiently co-ordinating both A.C. and D.C. operation to maintain high speed, and quantity production.

For all steel mill auxiliary control applications, consult your nearest CLARK *office for approved time-proved and accepted* CLARK CONTROL.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

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"Rigid Economy, Men"

Pipes & Tubes

arteries, veins and capillaries of industry and commerce

Striped red wabbler rolls are the productioneering tools in mills which produce much of the present-day tonnage of ferrous and non-ferrous pipes and tubes. The size of this task is emphasized by the 1949 tonnages of ferrous pipes and tubes consumed by three industrial groups—

102,441 tons by automotive manufacturers
265,917 tons for gas and oil distribution
172,677 tons in electrical installations

The development of Mack-Hemp rolls for pipe and tube manufacturing has paralleled the progress by this industry in both welded and seamless methods of production. From the complete catalog of striped red wabbler rolls you can select the most efficient rolls for the specific jobs—such as the deep-chill grain type rolls for reelers, barrel rolls with a special low carbon alloy particularly selected for roll-bite, and sizing rolls of tough nickel-iron chilled Nironite.

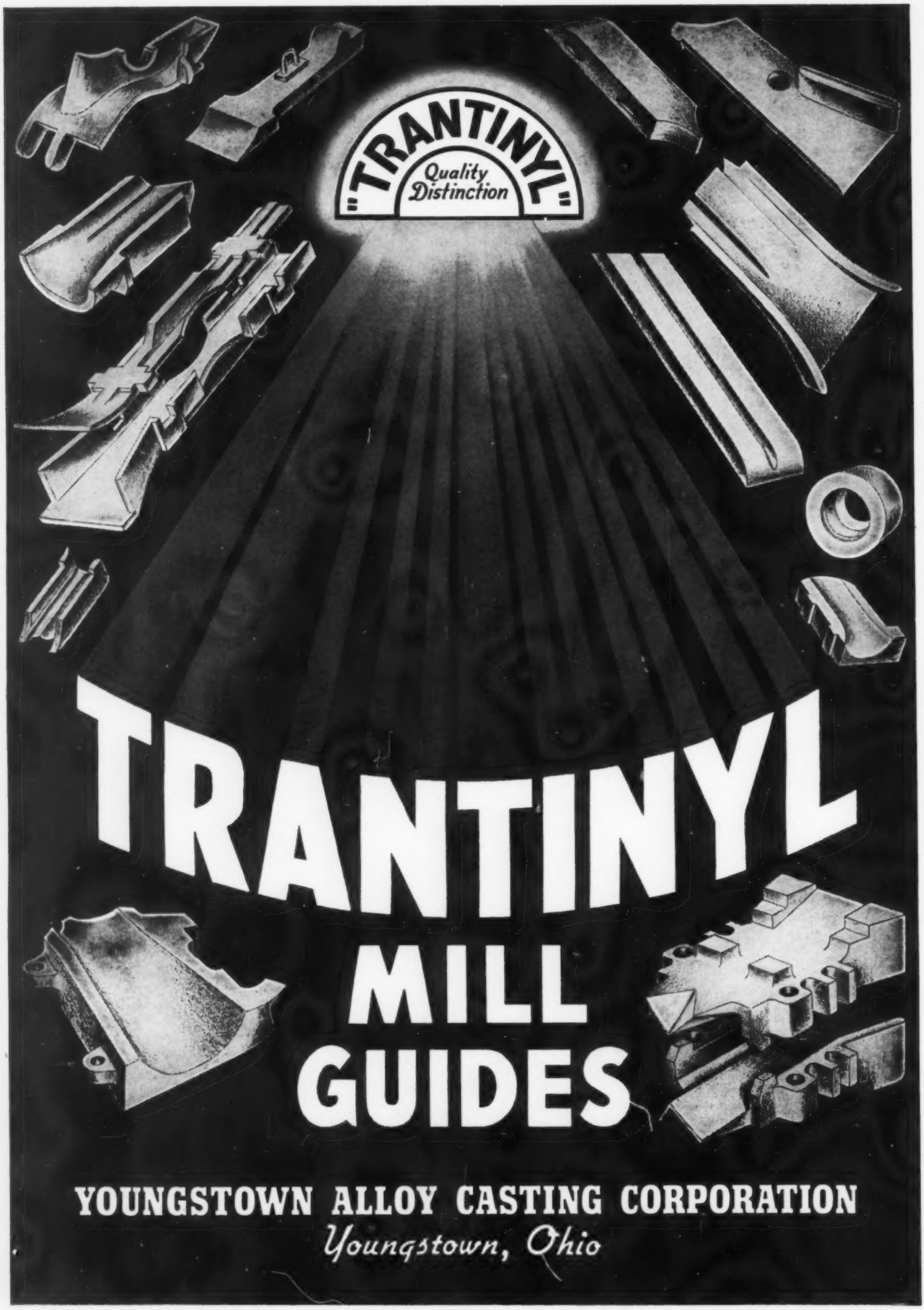
There's a Mack-Hemp roll with the proper metallurgical characteristics for every pipe and tube mill requirement. That's why it's important to keep an eye on what's new at Mack-Hemp.

MACKINTOSH-HEMPHILL COMPANY

Makers of the Rolls with the Striped Red Wabblers

PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Abramsen straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers.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Youngstown, Ohio

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To better serve the requirements of the trade and to operate at a profit in a highly competitive field, steel plant executives recognize they must have the most modern and efficient equipment available.

The Wean Engineering Company, Inc., Warren, Ohio, is the recognized leader in the design and installation of sheet, tin and strip mill equipment, whether it be one piece or a complete unit.

Many steel mill executives, both in this country and abroad, have recognized the advantages and efficiency of WEAN SHEET, STRIP AND TIN MILL EQUIPMENT. The same recognized advantages are available for overcoming your problems.

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Complete Installations for Electro Galvanizing, Hot Dip Galvanizing, Patenting, Tinning, Wire Flattening, Nail Galvanizing and Blueing.

Complete Equipment for the Manufacture of Hexagon Netting, Hinge Joint Fence and Barbed Wire.

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STRIP MACHINERY

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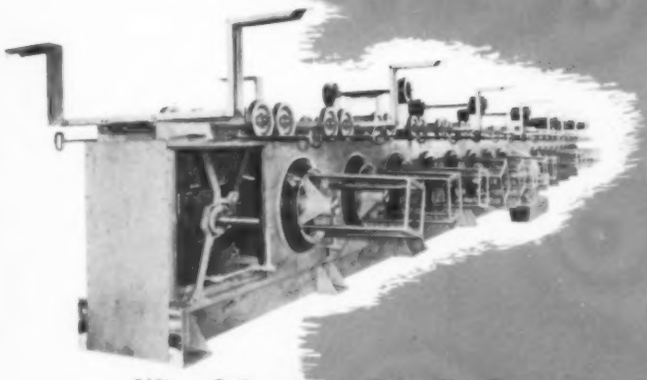
WEAN EQUIPMENT CO

Wire Machinery

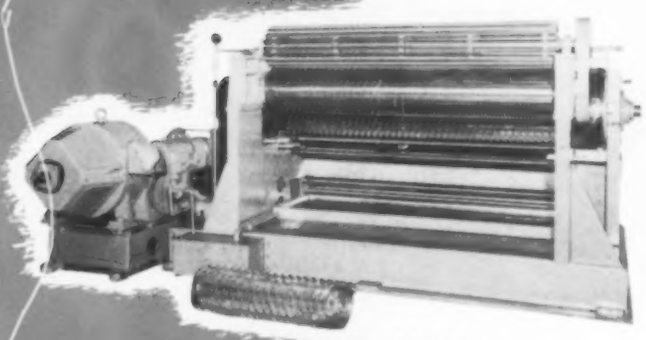
Process

2–Hi Wire Flattening Mill



Wire Galvanizing Take-Up Frame

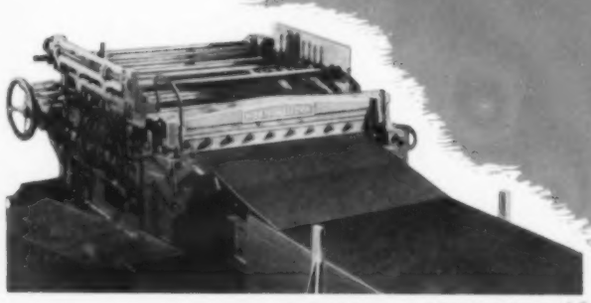
Product



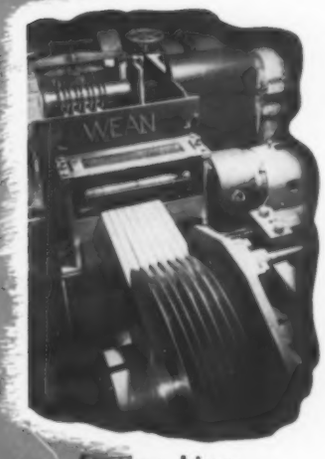
Hexagon Netting Machine

Nail Galvanizing Unit

Strip Machinery



Synchronized Automatic Shear Lines



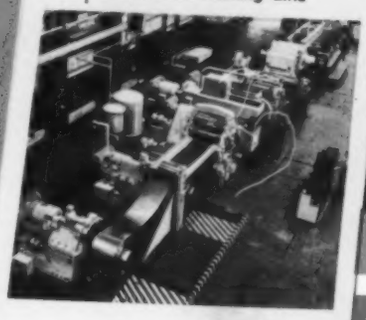
Slitting Lines

The WEAN ENGINEERING Company, Inc.

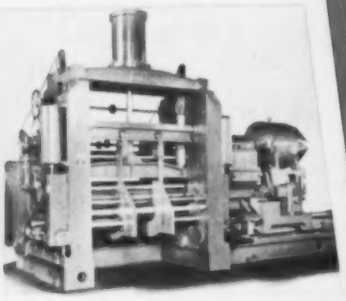
WARREN, OHIO

Continuous Strip Pickle Line

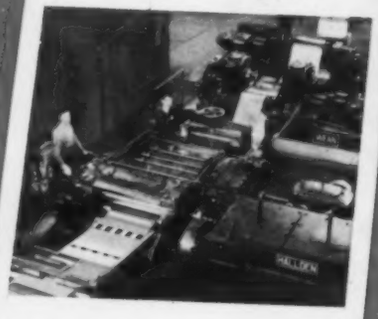
Continuous Coating Line



Processing Uncoiler

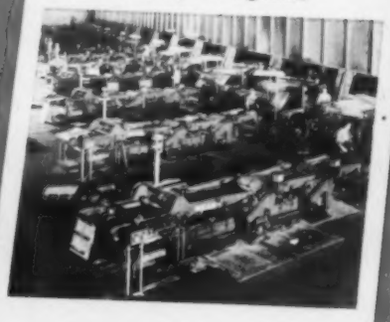


Tin Plate Shearing Line

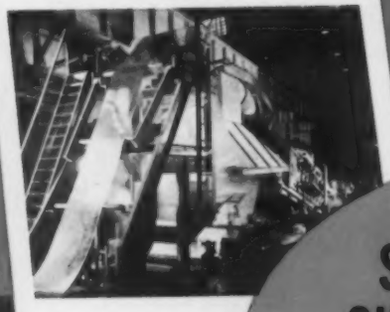


Continuous Electrolytic Cleaning Line

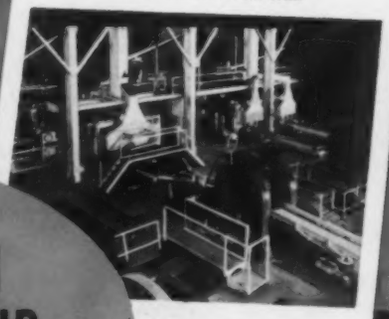
Hot-Dip Tinning Units



Continuous Hot-Dip Galvanizing Line



Mechanized Sheet Mill



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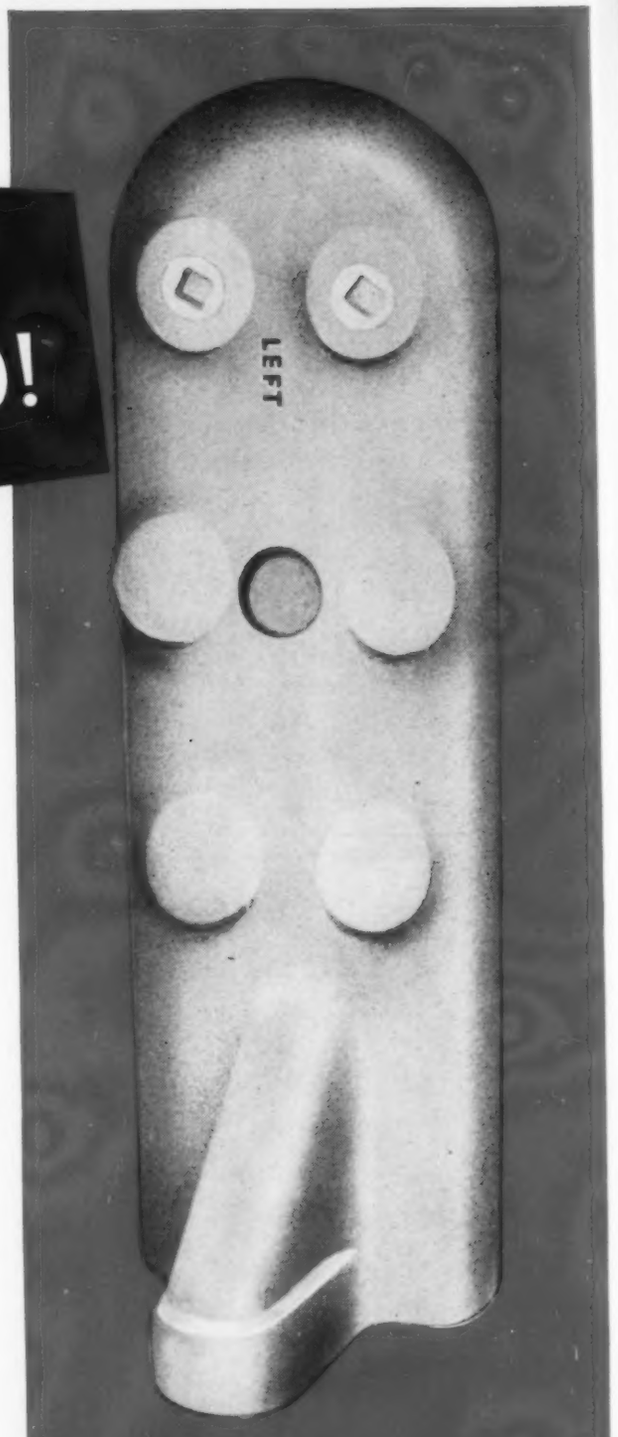

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National Bearing Division has complete facilities for finding practical, economical solutions to non-ferrous bearing and casting problems. Investigate these complete facilities—whether your problem requires designed engineering service, or production of non-ferrous parts to your own specifications.

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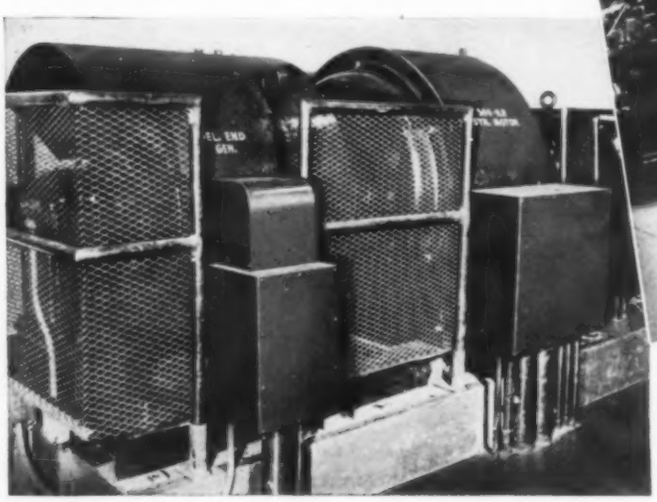
AT THE UNITED STATES STEEL COMPANY, IRVIN WORKS, the new 80-in. slitting and recoiling line is assured of dependable operation by Elliott Fabri-steel motors and generators especially designed for the most exacting needs of steel mill drives. Features of this Elliott equipment include flawless commutation, rugged construction, ready accessibility for inspection and maintenance, all backed up by painstaking attention to details in engineering and workmanship.

In their welded steel ruggedness, and pronounced reliability, Elliott motors and generators have gained a top reputation for steel mill service.



- At top, close-up of the tension reel motor—400-hp, 200/800-rpm, 600-volt dc, separately excited, force ventilated.
- Center, Elliott 150-kw 720/900-rpm, 600-volt dc drag generator for tension bridle; drip-proof protected, separately excited.
- At left, motor-generator set for variable voltage power. A 250-kw, 600-volt, 1200-rpm, drip-proof, separately excited dc generator, driven by a 500-hp 1200-rpm, drip-proof synchronous motor, which also drives smaller generators.

ELLIOTT COMPANY

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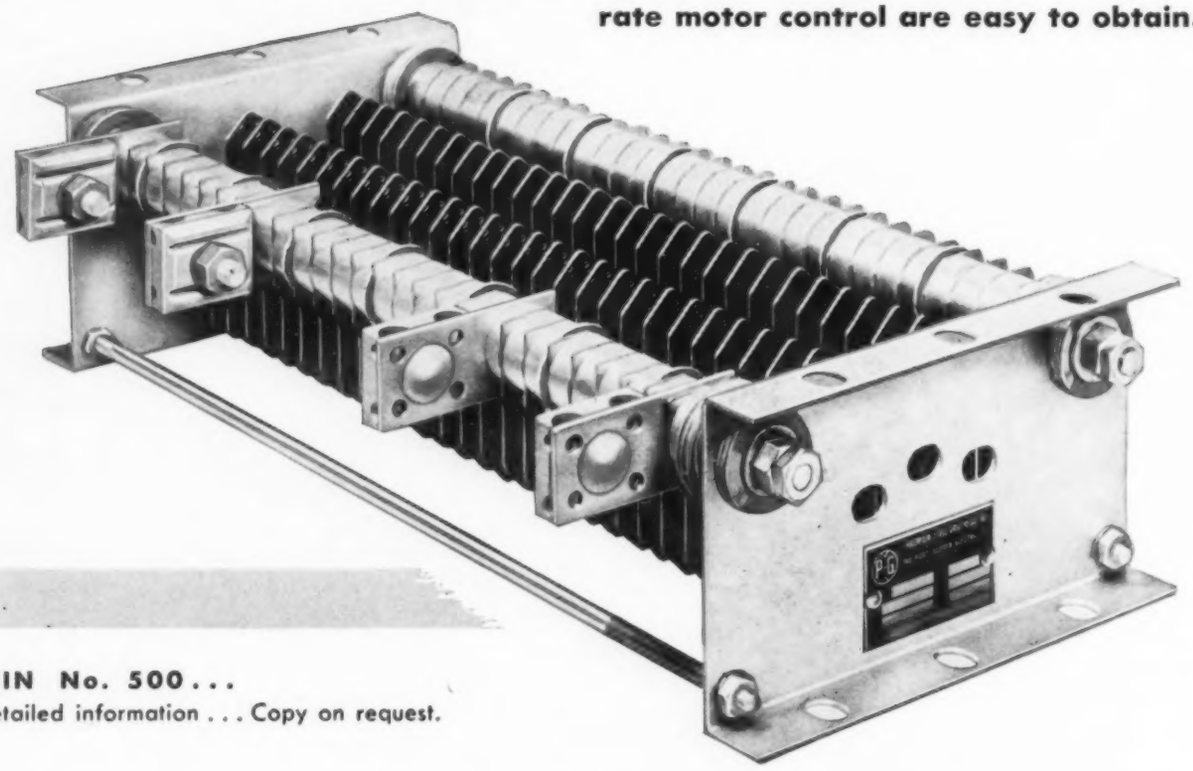

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Gives detailed information . . . Copy on request.

Flexibility in meeting current requirements, enables P-G Steel Grid Resistors to have *both* correct ohmic values as well as required capacities for each application. Naturally, this ability assures *accurate motor control*. Specify P-G for your next application.

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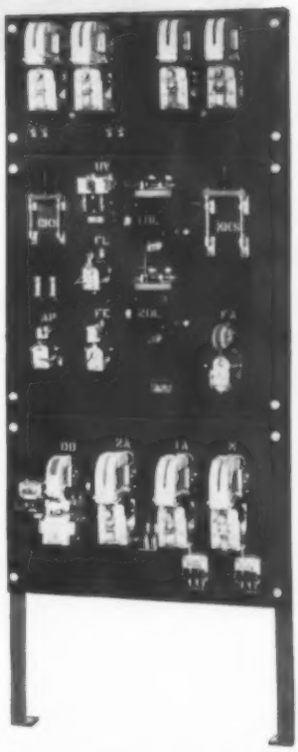
Here's a mill duty controller to go with them

Specify both Square D master switches and mill duty controls on your next tough application. They are available for D. C. mill auxiliary and crane applications of all types.

Call your Square D Field Engineer or write for Bulletins 9003 (master switches) and 7950 (mill control). Address Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.



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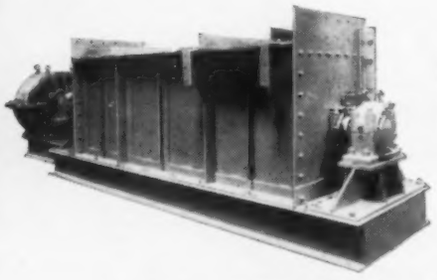
Bailey EQUIPMENT

PIG CASTING MACHINES

Ruggedly constructed for low-cost service, this machine is completely self-contained. If necessary it can be moved by crane and erected wherever needed. Once it is set in place, only an electrical connection is necessary for operation. Bailey Stationary Wheel design eliminates 80% of the moving parts of the conventional type. Capacities, 3 tons per hour to 50 tons per hour. Lengths, 15 ft. to 100 ft. in multiples of 5 ft. The standard Bailey machine for blast furnaces is made in lengths of 100 to 250 feet as required.

CLAY GUN

Best results and safety in plugging blast furnace tapping holes are obtained with the Bailey Clay Gun. A powerful electrically-driven piston assures unfailing performance. The special Bailey Lever Action forces the nose of the gun forward with positive accuracy. A powerful, motor-driven screw provides the piston pressure necessary to maintain long tapping holes.



PUG MILLS

Service records of up to twenty years continuous operation prove the soundness of Bailey Pug Mill design and construction. Types for either Dust Catcher or Sintering Plant service, single or double shaft, direct or rope drive. Bailey Pug Mills can be built to any required capacity.

In addition to the equipment shown here, Bailey offers the following items:

- **Cinder Notch Stopper**
- **Blast Furnace Cold Blast Valve**
- **Blast Furnace Blow-off Valve**
- **Check and Snort Valves**
- **Mixer and Check Relief Valve**
- **Blast Furnace Stove Checker**
- **Fabricated Steel Stove Bottom**
- **Precision Table Feeder**
- **Ladle Skulling Hook**
- **Check Valve for Cold Blast Main**

BRINGS *Safety* AND *Efficiency*

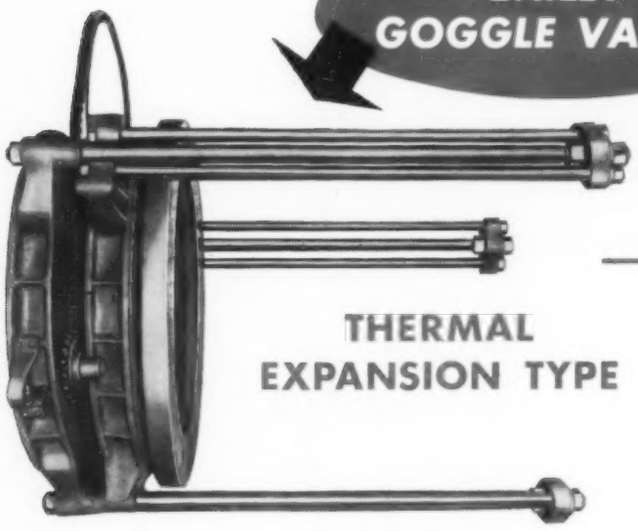
to ***STEEL MILL OPERATIONS***

Recognized throughout the iron and steel producing industry for dependability and highest quality, Bailey equipment meets the vigorous requirements of many vital operations. Some of the principal items of Bailey equipment are shown on these pages.

BAILEY GOGGLE VALVES

MECHANICAL TYPE

Bailey Goggle Valves provide a tight, positive seal for shutting off gas mains in emergencies or for repairs. They operate by a powerful clamping force which is applied equally at all points around the disc periphery. Regardless of time between operations, they open or close instantly. Sizes from 6" to 72", totally enclosed if desired.



THERMAL EXPANSION TYPE

The Bailey Thermal Expansion type Goggle Valve is operated by the linear expansion and contraction of the three sets of tubes spaced around the rigid steel flange. When steam is passed into the tubes, thermal expansion of the tubes frees the goggle plate. When the steam is removed, contraction closes the flanges against the goggle plate. Diameters of 36" to 120"

WILLIAM M. **Bailey** COMPANY

ENGINEERS

LEADERSHIP THROUGH QUALITY

1221 BANKSVILLE ROAD PITTSBURGH 16, PA

G-E drive for 48" continuous annealing and galvanizing line —helps speed production of uniform-quality light-gage strip!

General Electric engineered drive and furnace handles .012 to .040 strip at speeds from 50 to 300 fpm, for output up to 10 tons per hour!

To anneal and galvanize light-gage strip continuously, a large Pennsylvania steel mill recently installed a new galvanizing line complete with G-E drive and G-E electric furnace with protective atmosphere. Worked out co-operatively with Wean Engineering Co., Inc., the co-ordinated G-E drive makes possible these major advantages over former batch methods.

Higher rate of output—Galvanizing a given piece of steel now takes minutes, drastically reducing quantity of material in process.

A more uniform product—Corrosion resistance, drawing qualities, zinc adherence, and appearance are all greatly improved.

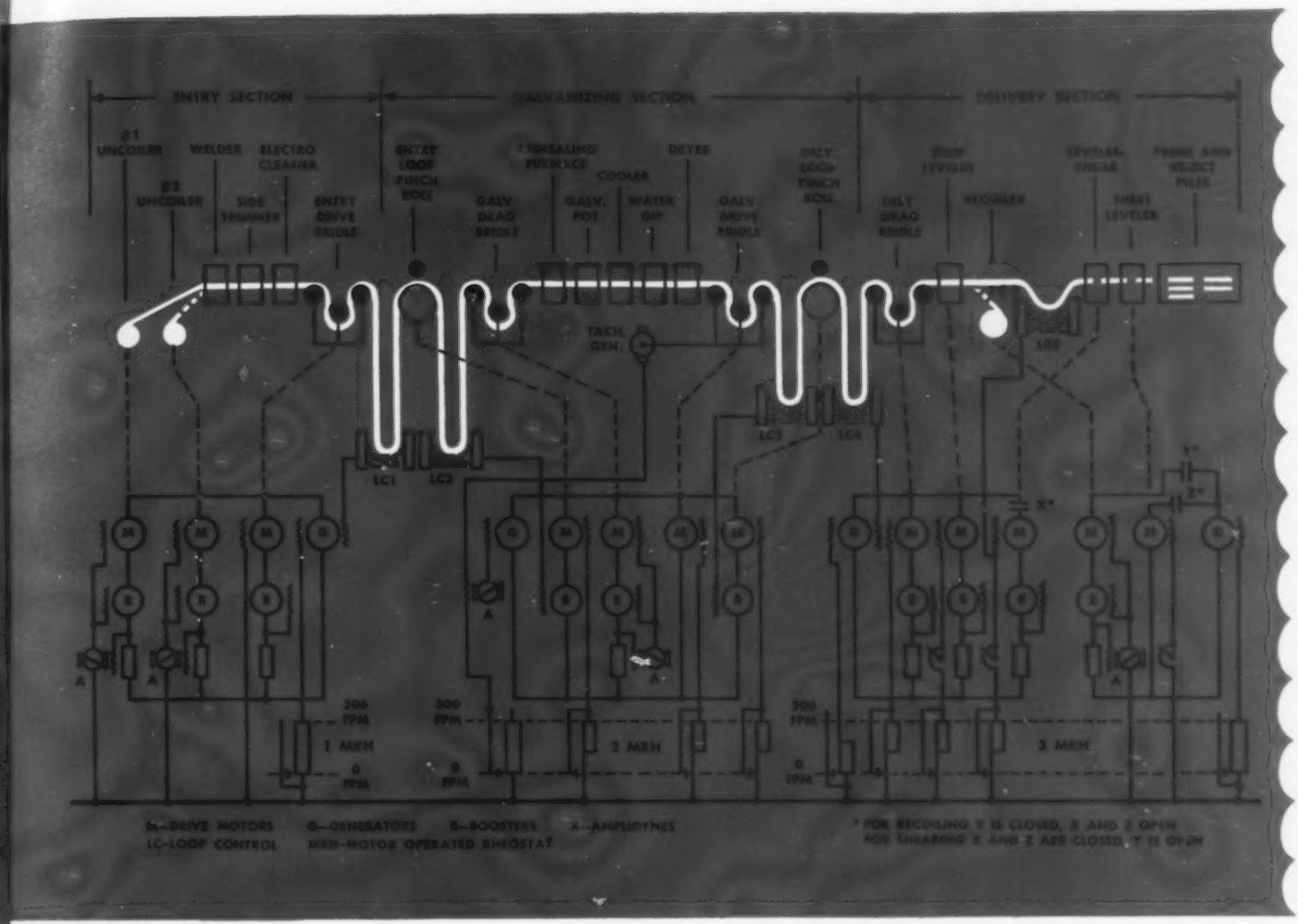
Lower operating costs—Manpower is freed for other duties, rejects are fewer, fluxing is eliminated, and zinc consumption held to a minimum.

Here is further proof that, for help in meeting *your* needs for higher-speed, more accurately controlled drives, your best bet is to call in a G-E steel-mill specialist—early. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

Co-ordinated G-E control in this line keeps output high, operating costs down, with features like these: 1) loop-filling-and-emptying control that permits maximum loop storage, protects against shutdowns; 2) automatic speed and tension controls minimize strip breakage and help maintain uniform product quality; 3) side-register control on re-coiler to maintain straight-edge coils; 4) welder control interlocked with line control to minimize welding time. Shown here in left foreground is delivery end of line.

GENERAL ELECTRIC

659-75



HERE'S HOW IT OPERATES

The drive for this continuous galvanizing line is divided into three sections which may be operated independently or in tandem. Amplidyne regulators maintain strip tension through each section and an amplidyne speed regulator holds strip speed constant through the galvanizing section. Looping pits provide strip storage to permit temporary shut-down of the entry section for welding, or of the delivery section for removing coils or stacks, without disturbing the continuous flow of strip through the galvanizing section.

The speed of each section is controlled by a motor-operated rheostat (1MRH, 2MRH, 3MRH). Approximate speed matching between sections is provided by automatic positioning of the motor-operated rheostats, and photoelectric loop controls (LC1, LC4) act on entry and delivery generator auxiliary fields to produce exact speed matching and maintain loop position.

The entry and delivery sections automatically overspeed after a shutdown to restore normal loop positions as quickly as possible. When either end section is shut down, the corresponding loop pinch roll is automatically operated at half of galvanizing section speed, thereby causing both halves of the storage loop to pay out or fill evenly.

This condensed diagram, including only major drives, does not show 13 additional minor drives connected to the adjustable-voltage systems.

another example of
GENERAL ELECTRIC
drive engineering at work!

A modern 15-ton, 120-foot span all-welded mill-type crane. One of 15 duplicate cranes on one order.
Hundreds of Cleveland all-weldeds are serving the tough jobs in steel mills. They will be found in nearly every modern mill built in recent years.

THE CLEVELAND CRANE & ENGINEERING CO.
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CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts

ABOUT a year ago, "mid-century" reviews were coming in like snowflakes in our recent blizzard. Now that we've actually reached mid-century, they've all been written. In case you're interested, the year 1951 is 2611 according to the Japanese calendar, 1370 according to the Mohammedans, 5711 in the Hebrew calendar, and 7459 in the Byzantine calendar. But we'll bet a lot of us are still writing 1950 on our letters and checks.

▲

UNITED States Steel Corp. has finally announced some details of its new Fairless works on the Delaware River. Present plans call for an integrated plant with an annual capacity of 1,800,000 tons of ingots, to cost approximately $400,000,000. This is a substantial increase over the original plans for this plant, and is almost equal to the $469,000,000 total of expansion projects announced by 18 other steel companies. These projects have been given the privilege of rapid amortization for the major portion of the expenditures.

Additional projects are under consideration, some of which will no doubt be carried to completion. The outlook for the proposed New England steel plant is improving.

▲

EVER since it became known that United States Steel Corp. had acquired an eastern plant site, there have been many rumors about other companies acquiring sites along the Delaware River. Materialization of the first of these rumors comes with the announcement by National Steel Corp. of its purchase of 2200 acres near Camden, N. J. Rumor has at least four other companies in the process of securing ground along the Delaware.

▲

MAYBE it's true that money talks, but ours seems to sneak off quietly when we aren't looking.

▲

A FRIEND of ours recently observed that the best way to avoid trouble is to wrong no man and write no woman. Around Washington, however, they've changed it to "write no one."

Actually, the Truman series of epistles, concerning the marines, Margaret's singing ability and the idea of a day of universal prayer for peace, is not itself particularly harmful. But to say the least, it is disturbing to see that kind of thinking on the part of the man who is supposed to guide the country through the troublesome times with which we are faced.

INCIDENTALLY, the retired grand opera star, Mary Garden, wired Mr. Truman: "Never pay attention to music critic. Save reviews to read Sunday with the funny papers. That's what I did for 30 years."

▲

MOST of us have become more or less reconciled to the gradual inflation we are experiencing. Most of us have attributed it to actions of our federal government, and have complained about it even while realizing that some inflation is perhaps necessary to carry the tremendous public debt. Nevertheless, it is quite a shock to see leaders of business and industry accept inflationary processes with apparent equanimity and without resistance. True, the speedy granting of recent wage increases and the immediate price increases will make immediate profits better than would a strike. But the readiness with which business and industry accepted the situation seems to indicate that the last line of defense against inflation is gone.

▲

AS David Lilienthal, former head of the Atomic Energy Commission, said: "Any person who wants to live a peaceful, quiet, uneventful life has just picked the wrong time to live."

▲

TOP supervision of the steel industry readily admits that maintenance is one of the most important of their problems, from a cost standpoint as well as continuity of operations. They express worry over the scarcity of good men in maintenance work. Yet, with few exceptions, maintenance personnel from top to bottom is paid less than production personnel, in spite of the fact that more knowledge and skill are often required in maintenance work. Many young men, after working for a time in maintenance departments, transfer to operating jobs because they can make more money and enjoy more attractive working conditions. They can't be blamed for this, and they will continue to transfer until maintenance work is given the compensation it merits.

▲

FROM an ad for a restaurant in a New England paper:

Roast Native Turkey	$2.50
Southern Fried Chicken	$2.50
Broiled Sirloin Steak	$3.00
Children Under 7 Yrs.	$1.25

▲

FROM the New England Letter of the First National Bank of Boston: "Faced with a prodigious task, we have no alternative if we are to maintain our solvency and integrity as a nation but to return to the fundamental principles that have been responsible for our greatness. Thrift, hard work, pay-as-you-go, incentives for business enterprise, and a rising productivity are among the foundation stones of what is called the American system. Any radical departure from these principles is not only reactionary and unworkable but also will jeopardize our national security."

▲

A PERSON with an hour to kill usually spends it with someone who hasn't.

Speer carbon brushes are especially designed to withstand the exacting demands of electric hoist motors. This means the ability to meet the high starting torque and frequent reversals necessary for full load performance.

By matching brushes to service characteristics, Speer has provided during the past 50 years, a complete line of brushes to meet all motor and generator requirements. Complete experimental and testing facilities are available for analyzing your brush requirements for machine designs or maintenance problems.

5922

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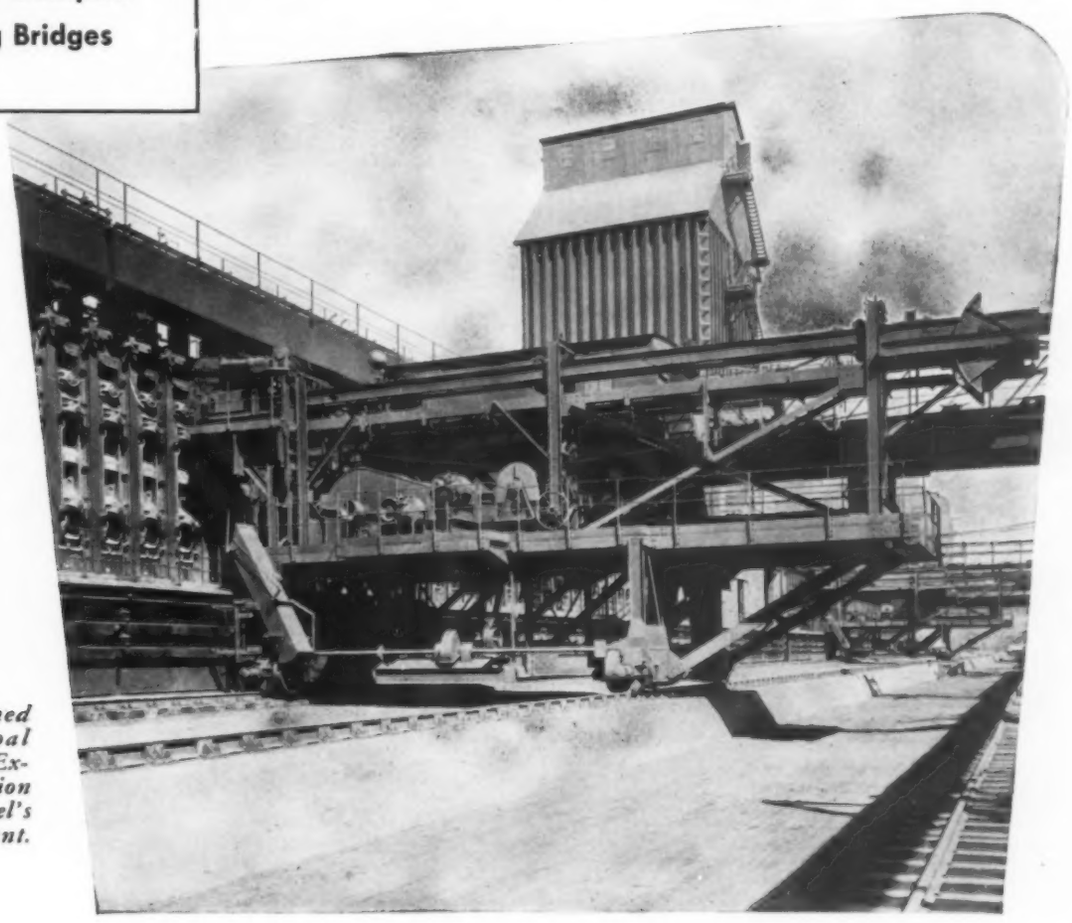
Wellman Coke Pushers

for the Modern Coke Plant



Wellman Combined Coke Pusher, Coal Leveler and Door Extractor in operation at Bethlehem Steel's Lackawanna Plant.

● Many of the world's most modern byproduct coke oven plants are Wellman equipped. The Wellman Engineering Company's more than half-century experience in building heavy machinery guarantees sound design and expert construction. Wellman equipment provides peak economy, maximum safety and trouble-free performance under a wide variety of operating conditions. For conservative, reliable recommendations on your heavy equipment, phone or write:

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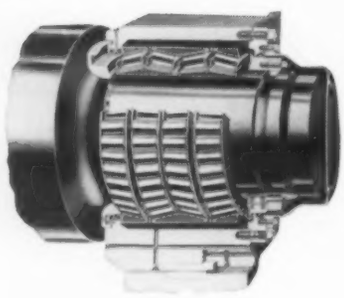
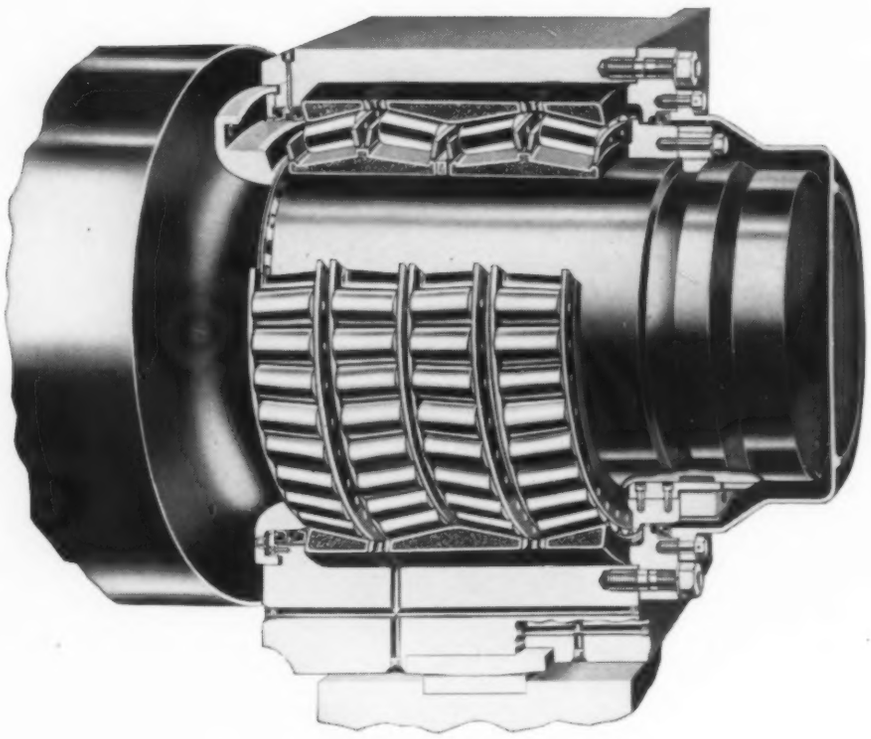
Look how this idea has grown in 17 years!



IN 1933

45 mills used Timken roll neck bearings.



IN 1950

317 mills used Timken roll neck bearings.

Just 17 years ago—in 1933—there were 45 mills using Timken-equipped roll stands. Today, Timken-equipped mill stands are used in 317 mills . . . more than seven times as many as in 1933. And in these 317 mills, the number of Timken-equipped stands in use totals 885.

Why has the idea of using Timken® tapered roller bearings on mill roll necks become so widely adopted? For all these reasons:

1. LOW BEARING COST. Tonnage records indicate that the long life of Timken roll neck bearings keeps bearing cost per ton of steel rolled to a minimum. Made of Timken fine alloy steel, rolls and races have wear-resistant surfaces, shock-resisting inner cores.

2. GREATER MILL RIGIDITY. Balanced proportion design of Timken bearings permits larger roll necks than ever before possible with tapered roller bearings. Average roll neck size is 71% of the O.D. of the bearing. Roll neck strength increased 50 to 60%.

3. ELIMINATION OF COMPLICATED LUBRICATING SYSTEMS. Timken bearings permit use of simple, economical grease lubrication. Rolls can be changed easier and in less time.

4. LOAD RATINGS INCREASED UP TO 40% due to Timken's balanced proportion design.

5. NO SPECIAL THRUST BEARINGS NEEDED. Timken tapered roller bearings take both radial and thrust loads in any combination.

6. MILLS CAN BE STOPPED AND RESTARTED WITH NO LOSS OF STEEL. Timken bearings permit mills to start smoothly and easily under full load. Gauge setting is not disturbed.

7. HIGHER ROLLING MILL SPEEDS are possible because Timken bearings minimize roll neck friction.

8. PROLONGED ROLL LIFE is assured because Timken bearings provide maximum roll neck strength, minimize roll neck wear.

You can be sure of all these advantages in either existing or new equipment by specifying Timken balanced proportion bearings for back-up and work rolls. Consult our roll neck bearing specialists for full details. Write The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

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NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⇕ AND THRUST →◯← LOADS OR ANY COMBINATION →✳←

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Iron and Steel Engineer

JANUARY, 1951 VOLUME XXVIII NUMBER I

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For Bulletin No. 7 giving you further data, write Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pennsylvania.

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

A REPORT OF ROLLING EXPERIENCES

By LOUIS MOSES
Superintendent, Rail Mill and Roll Dept.
Bethlehem Steel Co.
Sparrows Point, Md.

. . . . the roll designer's craft is said to resemble an art more than a science . . . . rarely does one see a paper which shows how the roll designer applies his art on a scientific foundation to solve operating problems . . . . the following unlocks some of the designer's secrets . . . .

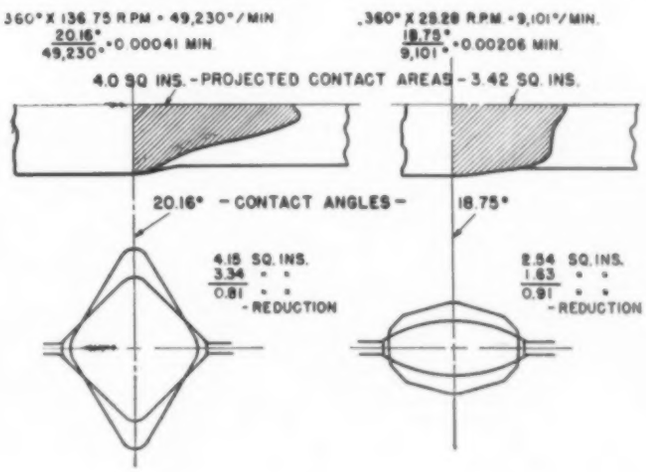
▲ INITIALLY, it is difficult to determine what experiences should be covered in this paper. The mills of the industry embrace such wide ranges of products, they are equally variable in their construction. Operational conditions and individual efficiencies are never the same in the several classifications. Classification suggests the many specializations where engineers and operators are skilled with certain products to the exclusion of others. Since there is no common denominator, the content of this paper was selected with the idea it would be of interest to more than one segment of the industry, not forgetting the roll designer's partner, the roll maker.

One subject bandied about concerns the optimum speed of mills. Maximum speeds, similarly to the top limit of tonnage possible in the melting processes, have not yet been achieved. Some years ago, 3000 fpm on a rod mill was considered a marvel. Satisfaction was expressed in our own time when 4000 fpm was successfully accomplished. Today 5000 fpm is built into new installations and this does not necessarily restrict the number of strands rolled simultaneously. Cold-reducing mills are operated at a mile a minute or more. High-speed mills are most costly to build and are served with more facilities than the older ones. In the light of what has been accomplished, future speeds for any product are impossible to estimate.

Aside from such speculation there is a choice of roughing speeds, in their relation to finished-delivery speeds, on which questions are frequently raised. Answers depend primarily upon the type of mill which is under study, but there are other considerations as well. If the unit is axially arranged on the same sole plate and driven from one end only, a compromise must be made between a desired delivery and a necessary entering speed. The first departure from this for added efficiency occurred when drives having differing speeds were installed at each end, the finishing being the faster. By this means, a 26-in. mill, with the rougher driven at 75 rpm, and intermediate and finishing coupled together at 95 rpm, handles several of the initially short passes in balancing the time interval in which the longer later lengths complete their passage. Four bars are thus worked simultaneously with sometimes five being on the tables at one time. Thirty-in. structural mills generally have the same speed across the train with these mills, which are also served with traveling tables, having more than one bar undergoing rolling at the same time. The speed characteristics of tandem and partially looping continuous mills are arranged with the speed of the first pass adjusted to the speed of the finishing pass in accordance with the ratio of volume delivered per unit of time in each. In cross-country mills, the roughing speed is higher in its delivering effect than would be a tandem mill in proportion to the objective of having a number of free-ended bars on the roller lines at all times. Roughing and intermediate speeds, with this in mind, are adjusted to the adopted finishing speed.

Granted that the finishing speed of a projected mill is determined upon, then a good index for roughing and

Figure 1 — The two cross-sections undergo approximately the same areas of reduction with about the same projected contact areas.


360° X 136.75 R.P.M. = 49,230°/MIN.
20.16°
49,230° = 0.00041 MIN.
360° X 25.28 R.P.M. = 9,101°/MIN.
18.75°
9,101° = 0.00206 MIN.
4.0 SQ. INS. - PROJECTED CONTACT AREAS - 3.42 SQ. INS.
20.16° - CONTACT ANGLES - 18.75°
4.15 SQ. INS.
3.34 " "
0.81 " " - REDUCTION
2.54 SQ. INS.
1.63 " "
0.91 " " - REDUCTION

		18"	ROD
A-AVERAGE TEMPERATURE OF ROLLED BAR	(DEG F.)	1,860	2,050
B-TONS ROLLED WITH COMPARABLE SURFACE	(G.T.)	1,500	80
C-BAR AREA	(SQ INS)	334	163
D-BAR WEIGHT PER ROLL REVOLUTION	(LBS)	516	16 9
E-BAR WEIGHT PER MINUTE (D X J)	(LBS)	7,038	426
F-REDUCTION IN AREA	(SQ INS)	081	091
G-PERIMETER OF GROOVE PROFILE	(INS)	325	250
H-WORKING DIAMETER OF GROOVE	(INS)	1733	1164
I-WORKING CIRCUMFERENCE OF GROOVE	(INS)	544	36 6
J-REV PER MIN OF ROLL		136.75	25.25
K-SURFACE SPEED OF GROOVE (I X J)	(INS /MIN)	7,439	924
L-TOTAL GROOVE SURFACE PER MIN (G X I X J)	(SQ INS)	24,176	2,301
M-PROJECTED CONTACT AREA	(SQ INS)	4 0	342
N-ANGLE OF BITE	(DEG)	20 16	18 75
O-AREA OF ROLL AT WORKING DIAMETER	(SQ INS)	236	106
P-VOLUME OF ROLL BARREL	(CU INS)	6,372	2,067
Q- TOTAL GROOVE SURFACE PER MIN / ROLL AREA	(L / O)	102 4 / 1	21 8 / 1
R- BAR WEIGHT PER MIN X TEMP / ROLL AREA	(E X A / O)	55,494 / 1	8,198 / 1
S- BAR WEIGHT PER MIN X TEMP / ROLL VOLUME	(E X A / P)	2 055 / 1	422 / 1
T- TOTAL GROOVE SURFACE PER MIN / BAR WEIGHT PER MIN X TEMP	(L / E X A)	00185 / 1	00264 / 1
U-TIMED CONTACT ANGLE	(MIN)	00041	00206
V-SCALE CONDITIONS		NONE	FURNACE
W- CONTACT AREA X TEMP / ROLL AREA	(M X A / O)	31 5 / 1	66 1 / 1

Figure 2 — Tabulation gives ratios with respect to heat input from the rolled bar and other data which was developed in Figure 1.

intermediate speeds would be a selected tandem continuous-type mill of similar size, allowing for cross-sectional areas of finished product and size of semi-finished to be entered. Adaptations can be made therefrom for any type of mill.

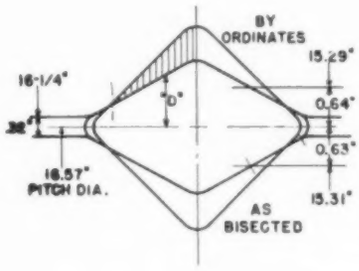
This occasion is not a particularly good opportunity to discuss this speed phase as it is a subject in itself. At the inception of the Rolling Mill Division of the Association of Iron and Steel Engineers, an objective was to ultimately publish a work on rolling mills in general which would parallel "The Modern Strip Mill," written by T. J. Ess and published by the AISE. With this remaining for the future, the suggestion is offered at this time that pending such a volume, arrangements be currently made in developing and publishing a tabulation of the industry's mills for ready reference. Such data are only presently available from privately collected files, a comprehensive compilation would not only be valuable but timely.

Mills today must give far more than lip service to the trade's demands for quality surface on rolled products. One handicap on tonnage producing mills lies in roughing mills, which even under restricted run durations, deliver rough surfaced bars whose surface condition can extend to the finished product. It would be ideal if the worst surface would approach that which would be made from a sand-blasted roll pass or even one which would resemble the fine-grain leather of a pocket wallet. In fact, considerable progress to such an end has been made. The thought has been advanced that roughening proclivities would be lessened if the timed passage of a given arc of contact could be increased. An alternative would be in enlarging the cubical volume of roughing-roll bodies, the better to conduct away applied bar heat. Some comparisons are given in the following examples:

Some years ago in searching for improved roll materials capable of withstanding such exposure, it was believed that a presentation of the elements of the problem would assist the roll-foundry metallurgist. An experiment was run in which a specific grading of chilled-grain roll metal was used as a control in the sense that it was applied to 18 in. × 27 in. rolls, finishing billets in a billet mill, and to 12 in. × 19.5 in. roughing rolls producing an oval in a rod mill. Sample ovals were taken at intervals until the surface condition corresponded to that of a representative billet. Single-pass performance of each position showed the balance to be 1500 tons from the 18-in. rolls, but only 80 tons from the 12-in. rod mill roughing rolls.

Figure 1 shows cross-sections, projected-contact areas and other details of the two cases which determine the particular selection of the oval position in being the closest available to the billet. A difference is due to the smaller roll working on reheated steel, from which, however, most of the remaining furnace scale had been broken away in the preceding pass.

Figure 2 shows the same data in tabulated form and establishes certain ratios between the two cases. All



ORDINATE	AREA	"D"	MOMENT
1	.032	1.05	.0336
2	.062	1.04	.0645
3	.059	0.99	.0584
4	.057	0.94	.0536
5	.050	0.88	.0440
6	.046	0.83	.0382
7	.041	0.77	.0316
8	.035	0.72	.0252
9	.030	0.66	.0198
10	.026	0.61	.0159
11	.021	0.55	.0115
12	.016	0.49	.0078
13	.012	0.44	.0053
14	.007	0.38	.0026
15	.004	0.33	.0013
	.498		.4133

$\sqrt{.4133} = .642$

Figure 3 — The effective working diameter when reducing a square to a diamond developed by the moment method is compared to the results by the bisecting method.

of the items were considered in looking for outstanding variations and are reproduced here with the thought that some other student might derive something more than your author's summary. This consists of noting that the oval's comparatively rapid deterioration was created by two major causes.

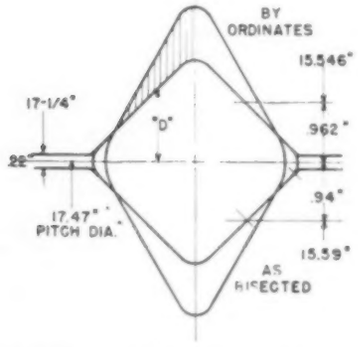
It is readily seen from item "U" that the angle of contact (bite) with the smaller roll's surface requires five times more time to make its sweep of 18.75 degrees than does the larger roll at 20.16 degrees of arc, resulting in that much additional exposure to the hot bar before contact ends and water can be applied. Item "W" is a comparative ratio involving cross-sectional area of the rolls showing that more than twice the amount of heat from the hot bar must be absorbed or conducted away by the smaller roll per square inch of roll-body area. To make matters worse, this value for "W" must be doubled because of practiced two-stranding. Further, and still worse, is the existing condition where three-stranding, not two, is in effect, which increases the smaller roll's stated value of "W" by three times, for such is the quantitative rate of exposure to bar heat. This renders a combined evaluation of item "W" for the small roll at 198:1 as compared with 31.5:1 for the 18-in. roll. In other words, with a heat absorption rate of 31.5 per square inch of 18-in. mill roll-body area, each square inch of the smaller roll must carry relatively 6.3 times as much.

Can this be a case of the larger roll being a better agency than water cooling because of body volume or is the larger provision of circumference for more water

the answer? The writer believes that both are involved with the greater emphasis on volume. In exploration of this, a further comparison considers 16⅛-in. × 36-in. rolls performing practically the same function as the described oval, but with four-stranding practice and with a marked and very considerable lessened pass roughening under comparable run durations. These surfaces approach the grain-leather simile. The product of the same items "M" and "A," multiplied by the number of strands rolled, divided by the product of roll area and body length, renders a comparison by roll body volume. It is thus found that the quantitative stated rate of heat units per cu in. of roll body is in the order of 102:1 for the three stranding 12-in. roll; 41.1:1 for the four stranding 16-in. roll and 11.7:1 for the one pass 18-in. roll. (There is no present means to establish actual Btu heat transfer values.)

On being acquainted with this matter, an engineer advised he envisioned a mill having speeded-up roughing stands delivering bars into a long holding furnace or cover in which bar heat could be conserved until the bar could be received by the finishing stands. Without the use of such a cover, a modern mill presently operates three stranding with its roughing stands delivering at a faster rate than the finishing can receive, bar by bar. The bars lay on the looping tables with the practice amounting to the roughing stands delivering three bars out of two strands in the same time interval that the finishing rolls three bars in three strands.

Cooling water application to rolls is of vital importance. This is a subject in itself with reams of research



ORDINATE	AREA	"D"	MOMENT
1	.0472	1.62	.0764
2	.0939	1.61	.1512
3	.0932	1.56	.1454
4	.0855	1.48	.1265
5	.0770	1.38	.1063
6	.0684	1.27	.0869
7	.0600	1.17	.0702
8	.0515	1.07	.0551
9	.0429	0.97	.0416
10	.0342	0.87	.0306
11	.0259	0.76	.0197
12	.0174	0.66	.0115
13	.0089	0.56	.0050
	.7060		.9264

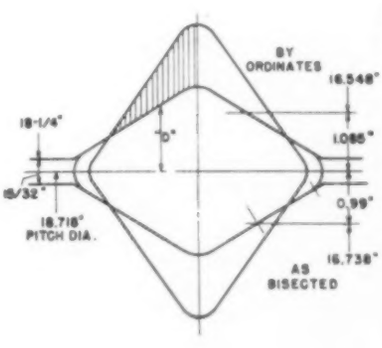
$\sqrt{.9264} = .962$

Figure 4 — Effective working diameters are compared when reducing a diamond to a square.

involved, and a multitude of ramifications to consider. Take the case of a leader pass having its side wall forming the base of a railguttering after only 500 to 700 tons, and requiring 1/16 in. side cutting to restore to requisite straightness. With the limited tolerances there could be only two and at the most three runs before the rolls would be scrapped. This problem was solved by a compressed air blast, operated by a switch on the lifting table at the entering side, the air blowing all water from the pass so that none could enter with the bar. This enabled the rolling of up to 2000 tons, sometimes more per installation, and with five or six runs possible without a sign of guttering. On a preceding pass of like construction, a similar condition was corrected by reducing two-thirds of the accustomed water and arranging an adaptation of a fireman's spray nozzle on the delivery side to prevent water entering into the pass. Take the case of the passes in a 12-in. roughing mill where water was applied for many years in the usual manner by cascading it down both sides of the grooved rolls. This was in line with the customary conception of having as much water flow over the revolving roll as was possible, and also allowed water to enter the pass along with the bar. By arranging water to hit the roll at an approximate angle of 45 degrees on the delivery side only, there is no carry over and very little water, if any, freely enters the roll gap. Through this amended practice, the pass surfaces are in far smoother condition at the end of routine runs, and require dressings of only one-half the former amounts. Then there is the use of the adapted spray nozzle applied on the delivery side of passes, this more than doubling the pass life on a billet mill, and the same principles vastly prolonged the life of structural channel rolls. Care must be taken to avoid placing the streams too close or too low to delivery guides which would allow water to flow backwards into the pass. An instance of this is known where the emerging front ends were dangerously cooled for entry into succeeding passes.

The principle is to apply water on the delivery side only, and use any practical means to prevent water from entering the roll gap along with the bar. Beyond the shadow of any doubt, steam is the offender far more than abrasion. Many of you have seen ragging grooves in a blooming mill box pass, terminated by the shop as much as 1½ in. short of roll groove fillets, come out of the mill extended and partially around the fillet radius by the action of escaping steam. Despite the admittedly small amounts of water going in with the roll, who knows what the pressures amount to when flash generated at 2000 F and which must somehow escape? The violent eruptions, minute as they may be individually, can cumulatively account for deeply pitted pass surfaces. Actual wear as manifested by a severe change of shape is more likely to be caused by abrasion accompanying heavy drafting. No one can blandly advise cutting down water to the possible destruction of a roll, or even to the extent of bluing it. There must be some judgment and discretion applied by the experimenter and the job must be done in small doses. However, the subject encourages study with trials at the risk of extra roll changes well worth while in the end.

Figure 5 — A diamond into a diamond creates greater spreading as shown by the computations from the moment and bisecting methods. Emphasis is on the bisected contact face as being the most accurate.



ORDINATE	AREA	"D"	MOMENT
1	.0511	1.57	.08027
2	.1002	1.56	.15631
3	.1002	1.52	.15230
4	.0942	1.46	.13753
5	.0868	1.39	.12065
6	.0796	1.33	.10587
7	.0725	1.27	.09207
8	.0653	1.21	.07901
9	.0578	1.15	.06647
10	.0507	1.08	.05526
11	.0434	1.03	.04470
12	.0362	0.97	.03490
13	.0290	0.91	.02639
14	.0218	0.85	.01853
15	.0145	0.79	.01145
16	.0072	0.73	.00526
17	.0015	0.66	.00010
	.9120		1.18907

$\sqrt{1.18907} = 1.088$

In continuous-mill pass design, the three factors of bar area, rpm of rolls, and roll diameters when multiplied together produce constants. When these are held relatively close to one another in a system of reducing passes, the combined action of the train of grooves generally meets requirements. On flat work the diameter of the plain roll surface becomes the diameter factor, but an effective working diameter must be located for grooved work. There are various methods employed in locating this latter point, one using the center of gravity of half the section. Somehow the bars we roll are not educated to the point of being aware that they possess the property, and the author, sorely puzzled and disillusioned in his early experience by some of the then recommended procedures, determined to analyze the action of the metal undergoing reduction in a groove.

This study superimposes the shape of an entering bar over that of the working pass as shown on Figure 3.

The work performed down the vertical center line, being greater than at any other point, is the greatest contributing influence that would cause the bar to hug tightest to the roll, and assumes the latter's delivery speed at this groove apex. This occurs at the smallest circumference. That part of the imposed shape on which the least amount of reducing work is performed has the least influence by such analyses. But there is some influence which is significantly exerted at the largest circumference of the groove. To consider these extremes along with intermediate influences, a section of the change in shape is divided into any convenient number of ordinate areas with each of these radially measured from the pitch line of the roll. Multiplication of the two produces individual moments with the square root of their summation becoming an average moment applicable to the whole bar. In this case the derived dimension is 0.64 in. which radially expressed becomes 15.29 in. as the effective working diameter.

This requires much effort. As a check, the procedure is good reasoning but does not go far enough. Some profiles when imposed upon each other have more spreading action than others. Without too much thought, it is apparent that there will be a balancing of all influences, resulting in slippage present at every point save one where bar speed and groove circumferential speed coincide (so far as our purposes here are affected). Portions pressing heaviest against smallest circumferences are opposed by portions with lessened pressures exerted on largest circumferences. The plastic bar therefore either travels faster and slips against the groove face at some points, or at others it moves slower and the roll slips over the bar. The fact that our bar is plastic, and that its surface particles adapt themselves to such conditions, does not alter the conception of slippage.

What about bisecting the line of contact on the groove's profile, making sure that side fill is correctly drawn? By doing so, it is found that the corresponding average value of "D" is 0.63 in. which brings an effective working diameter of 15.31 in. The difference is so negligible that this bisecting method has been confidently and successfully employed for many years. Many other designers found it to be the most practical way and it is in general use.

From the data at hand on Figure 4, it can be seen that the two treatments differ by only one-quarter of

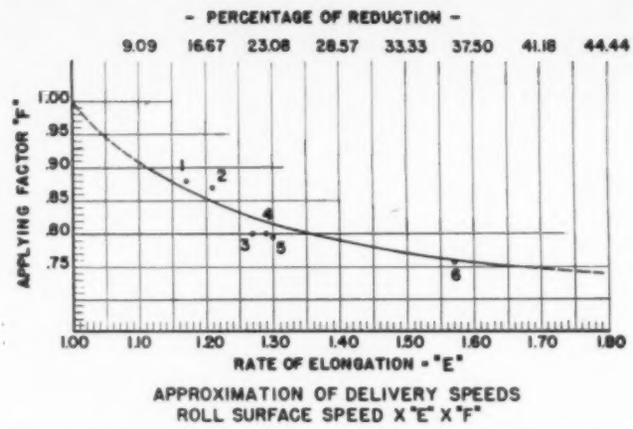


Figure 6 — By applying factor "F" to the product of roll surface speed times rate of elongation, a fairly accurate emerging bar speed is obtained.

one per cent on the diameter. In another interesting example shown in Figure 5, a greater amount of metal displacement occurs to the accompaniment of more change of shape. Here the subdivision by ordinate areas produces an effective working diameter which is 1.13 per cent smaller than found by the bisecting method. However, this groove, sized by bisecting, works to such entire satisfaction that it belies that much error. Digging into this, it is noted that considerably more spread occurs than with the preceding examples. Because the superimposed shapes have an absence of ordinate area at the region of roll partings, there is no means of establishing moments or influences at such portions because none can be found without areas. Yet the completed and delivered shape near the partings has its pronounced influence on our sought for point, we know the groove works well without push or pull, and the bisecting method produces the more accurate effective working diameter because it embraces all influences.

The described bisecting of bar contact line with the pass is applied equally well to ovals, rounds or the much more touchy tubes. The accurate determination of the point is of particular importance to geared trains of continuous mills where there is no means of changing roll speeds. Many modern continuous mills have individually driven stands with variable speed motors, nevertheless the finding of the effective working point is no less necessary because the operators must have designated speed settings.

Subtle variations not yet fully analyzed have been found to exist, mostly during long periods on tonnage producing mills where delays or impediments are so serious. For instance, an arbitrary change of increasing roll diameters in one stand of a 10-in. rod mill by $\frac{1}{16}$ in. and decreasing by $\frac{1}{16}$ in. the succeeding stand, eliminated an excessive condition of wear which handicapped the mill after running for a time. Also, it incidentally reduced roll dressing one-half. The constants had been assumed to be within the ordinarily allowed limits of calculated error. This brings to mind a finishing-stand experience where the constant was also considered to be sufficiently correct during many years of two-stranding practice. Two-stranding permitted the roller to adjust his rolls vertically at either end at will to suit whatever gage variations existed between the two strands. On the advent of three-stranding, diffi-

culty was had through variable sizing of rods coming from respective strand lines, although all of the latter were made to micrometer exactness. Actually, four grooves are used across the face of the roll so that settings must be exactly parallel with no further adjustments possible in effecting gage. It was found that the dimensions of cobbled leader bars, as averaged from all four of the strand lines, constituted a rather stubby oval with a width to thickness ratio of 1.81 to 1. This proportion is a difficult one to "stand up" between the entering guides of a rod-finishing pass with variable leaning at respective strands the cause of varying gages. By arbitrarily increasing the finishing-roll diameters by ¼ in., the settings of all the stands in the train were made in accord with the larger finishing roll. This resulted in a consistently delivered finishing oval sized in the ratio of width to thickness of 2.16 to 1 which eliminated this difficulty.

It was obviously necessary to continue the above developed advantage which now created a serious complication. The roll foundry suppliers have always had trouble in providing an accurately regulated clear chill depth when specified at the upper limits of chilling practices. More often than not, deliveries erred on the shallow side to avoid chilling into neck fillets. There is also the requirement that no mottled iron must show at 9½ in. diameter when the outside diameter was at 11⅝ in., or a radial clear chill depth of 1 1/16 in. which, as stated, is difficult to produce. Now 1 3/16 in. was demanded, because in the process of rolling a quality surface, a groove showing mottled iron in any part of the mill would be immediately apparent on the finished product. This paragraph on experience is included because the foundries rose to the occasion admirably. If they had not been able to do so, either gage or faulty surface would have to be sacrificed.

Figure 6 concerns the rate of speed of a delivered bar undergoing reduction. There have been occasions when more than an ordinary conception between entry and delivery lengths was required. There is little information from which to make an accurate or authoritative curve, but that offered here may be sufficiently thought provoking to induce others to make further studies. The first assumption is that a bar of given thickness when entered between a roll gap of the same dimension, neglecting slippage or friction, will deliver at the identical circumferential speed of the rolls. We next know that a bar undergoing reduction cannot enter the gap at the surface speed of the roll, because of the obvious braking effect of the entered thickness. It is also well established that a reduced bar emerges faster than the roll surface speed because of elongation.

One means of determining the relative speed effects is to compare resultant lengths between marks on bars made by a circumferential marking on the roll surface. The timing of long respective lengths is another method. By either one, a fairly accurate calculation can be made with entering and delivered areas as a basis. Reduction of area can be stated in terms of elongation. This would provide a delivery speed only on the assumption that the thicker bar entered at roll surface speed which it cannot do. From reliable data taken over the years it is found that an elongation of 1.57 per cent is accompanied with a delivery speed of only 76 per cent of the product of roll surface speed times total elongation. At the other extreme of information at hand this ranges to 88 per cent when total elongation is at 1.17 per cent. These, and other data, are plotted as a curve which provides factors for intervening cases, the extensions merely being probabilities.

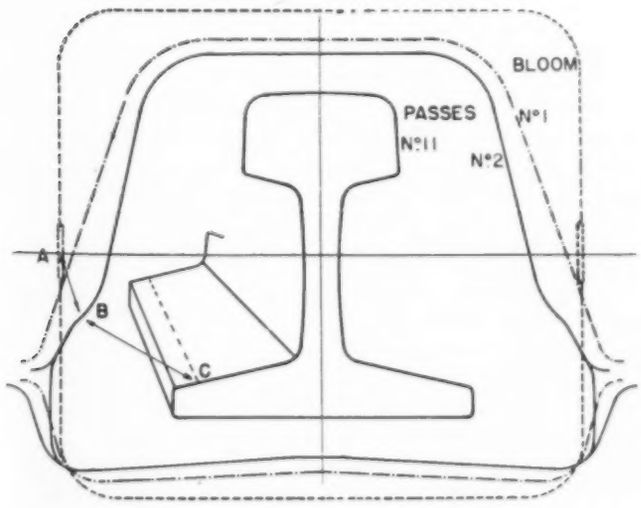
No mathematical problem is correctly solved except by adequate checking, preferably by an alternative method. As presently applied, this curve serves as a check against the results obtained when developing the usual constants. In practice there are a multitude of variables affecting the problem, such as the kind of roll material, slippery or roughened surfaces, cooling water applications, roll body lubrication in cold strip mills, push or pull adjustments, etc. All of these sundry influences importantly affect the one common factor of friction, great or small, between bar and roll, which draws the bar into the roll-gap.

A successfully operating gear-driven, tandem arranged, 18-in. billet mill with rolls designed over the described constants provides means for comparing the factor values of Figure 6 against actualities. Through such factor applications, the speeds of emerging bars versus entering speeds of next succeeding roll stands, would vary from 3 per cent to less than 1 per cent at different mill locations. As it is known that no conditions of push or pull exist, the curve can be considered as being accurate within such limits.

The study is confined to flats, squares, diamonds, ovals and rounds, but these findings may or may not be applicable to shapes where more data is required. So far as the writer knows, there are no determinations made in like manner on the comparative speeds of roll and bar in cases of embossed-bar rolling. Embossings to a desired pattern are produced by machining suitable depressions in and across the faces of lathe-turned roll grooves. Here the influences of such supplemental pass contouring completely nullifies the above findings which are only applicable to ordinary roll faces or grooves. Much study and experiment is required before findings can be offered on the so-called "deformed" grooving.

To effect bar manipulation by the aid of the customary and widely used twist guide, the design of the guide becomes a very important matter, in many respects being no less so than the roll-pass design. The

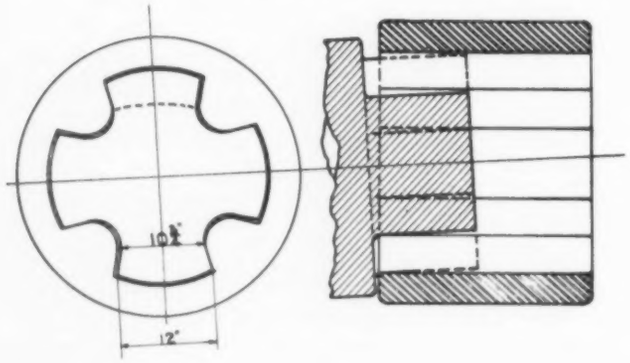
Figure 7 — A surface defect on bloom center line was actually transferred to an apparently unrelated position on the finished roll section.



shaping of the interior of such guides is frequently and erroneously based upon creating the desired full spiral by confining the latter's considered length to be the same as the distance between stand centers. This does not allow sufficient twisting to safely and consistently conduct the emerging bar end into the succeeding entry guide without the hazard of cobbling. Experience indicates that such basing makes the guides too tight. Some designers shorten the considered length of spiral by deducting from stand center distance the effective length of the succeeding entry guide. At your author's plant a highly successful method has been in use for many years which basically considers the stand centers and arbitrarily adds 10 per cent to the required angularity of twist in such a distance. Twisted bars have some elasticity and spring back, the entry guides shorten the stand-to-stand distance, the roller cannot have his guide too tight and risk damaging scratching. This practice of adding 10 per cent makes for a slightly loose assembly, the bar wears the guide to a seat very easily, there is ample clearance at guide partings for closing in and thus obtaining longer life. The interior shaping at the back, or delivery end, is made to a full bearing against the bar for not less than 40 per cent of guide length. This is done to provide adequate wearing life, for without such bearing the guide would quickly wear and lose its twist. If the bar fit, however, is made the same throughout most of the remaining 60 per cent length portion, the bar will be scratched from pick-ups. Therefore this region is bell shaped for ready bar entrance from the roll gap to give a gradual approach to the twist but without too much abrupt flaring. The importance of this lies in possibilities of scratching being concealed within the guide interior, with no sparking in evidence for correction. Twist guides on small mills are usually quite thin. The holding-down wedges deflect the central portions of the top-guide member, especially on such equipment applied toward the finishing end of the mill. Design of the interior of guides here must consider this bending at the center. This latter does not concern larger guides on larger mills but all the other mentioned design features are observed in design.

A 12-in. skelp mill was operated for a long time with 8-in. diameter necks. When the product range of the unit was increased to $11\frac{3}{16}$ in. wide flats, the necks were also increased to 9 in. diameter. The move was wise because no neck breakage occurred. The point made concerns an unexpected by-product when the operators found that all gages from the smallest width were far easier to hold throughout the day. A similar situation occurred with a 21-in. mill where necks were increased from 15 to 16 in., without which the widest widths rolled could not be otherwise held parallel in thickness and with hazards to neck breakage. Composition water-lubricated bearing linings were retained at the same 120 degree included angle of neck contact. This increased the projected contact area of bearing by some 12 per cent, which accounts for some of this desirable improvement. A further factor lies in roll-body deflection which is more than theoretical, but rolls on most mills are large enough in diameter to preclude material or actual springing at the center excepting long plate mill rolls which would affect gages. The smaller neck diameter creates a pronounced change in shape where deflection becomes clearly obvious, if only by noting the wear on bearing linings, with greatest wear adjacent to neck fillets. This is so great that with certain types of bearing construction, the fillets of a roll neck will often be found to be heat cracked with no such effect on the neck itself, showing that roll separating pressures are greatest at the fillet portion. This occurred to plate-mill rolls when babbitt linings were used. As a matter of fact the mill housings themselves, after extended usage and when in need of overhauling, are usually found to have much more wear on the inside of the bottom supporting faces than at the outside. Undoubtedly the improvement in operating conditions was also largely due to lessened amounts of neck deflection which distributed wear on the bearings and allowed for longer runs. Another example is at a rod mill where on going to three-stranding, the 50 per cent added load was cared for by 1-in. larger necks. While there is no definite comparison under identical conditions of neck size and number of strands rolled, there is no question but that the same operating advantage is had.

Figure 8 — Roll pods having a reduced throat dimension will create a wedging action when the spindle and box are not in alinement.



The illustration on Figure 7 refers to a long abandoned practice which, as may be surmised, lasted only long enough to be immediately stopped. With the supposition that a row of ragging was a necessity in the box pass of a blooming mill, the resultant blooms created marked flanges on a rail to an extent that the product could not be shipped. These markings were singularly accurately spaced. Relation between knurling-wheel pitch and spacing of the defect, to starting bloom length and length of finished product, was almost exact. This sketch exhibits how certain particles of a bloom's surface can be transferred by metal flow to an apparently completely unrelated region of the surface on a finished section. The knurling marks on the bloom are represented at "A," the metal at the center line is forced downward in such a pass to the starting of the flange in No. 2 pass. Once started at this point "B," they finished up at locations "C."

Figure 8 concerns an experience with a type of wobbler whose shape resembled a Maltese cross. With the top roll at its highest position, the driving torque is transmitted through the vibrating spindle which, at the angularity assumed and despite the ball wobbler thereon, also inclined the muff coupling box to some extent. Whatever this angle amounted to, the revolving assembly developed a locking action which prevented the faces of the coupling box pods from sliding against their

complementary faces on the roll wobbler. This occurred when the wobbler was at the quadrant shown on the sketch. If the roll pod was not literally pulled out as indicated by the broken line, the flute corners would come out of the mill in a badly spalled condition, one or the other being dependent upon the relative state of wear and resultant clearance between roll and box. The substitution of the conventional straight-faced pods provided a sliding action comparable to a universal joint effect, and eliminated many broken wobblers formerly encountered.

It could be that the designer of this wobbler had in mind a modification of radially-arranged contact faces. This is strongly to be desired, particularly because of long-wearing properties, but can only be used in places where the spindle and the roll are in line within fairly close limits. The cross-section of radially-arranged pod faces also resembles the Maltese cross and with angular drives would develop the same dovetailing or locking action described above.

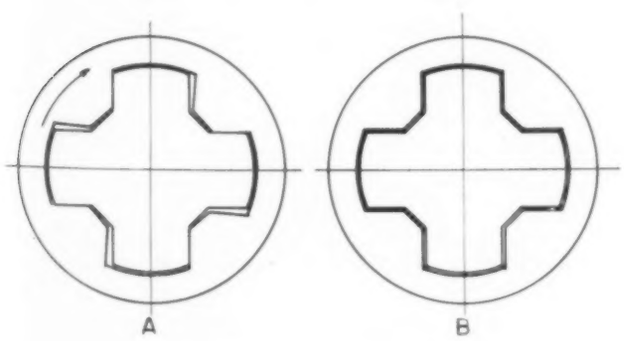
Figure 9 is another instance of this in lessened degree which manifested the error of such construction in another way. Conventionally laid-out straight-faced roll pods were wearing. It will be noted from figure "B" that when annular clearance is taken up, a point contact exists at the pod corners. The author tried shaping the core of the coupling box to provide a full-faced contact as shown on sketch "A" and eliminate experienced corner abrasion of roll and box. The extra amount of annular clearance so occasioned caused a terrific back lash when the plates left the rolls, which the brakes could not accommodate and the idea was abandoned.

Has selection of the foregoing experiences not been sufficiently practical? Many other problems could be brought up in a paper such as this. Could a better end be served by description of difficulties and manner of solving bar entry by comparing sheared cuts with sawed ends or burning? What is the influence of ends entered at an angle from tilting tables? What effect do we get from the many kinds of roll materials and the kind of ragging used, if any? What are the problems resulting from the various kinds of steels rolled, some of which are "slippery" and others dense and otherwise refractory in handling? Our opening paragraph stated that conditions differ widely. These detailed subjects for analysis could be recited, but it is doubtful indeed if enough of them could be assembled from which to make generalizations, certainly there is not enough time to attempt it here. Ingenuity, if not plain common sense, must be applied.

For instance, many years ago another inherited practice consisted of entering a 2¼-in. billet directly from the furnace into an oval pass and taking a heavy draft. Believe it or not, only very soft iron rolls could be used because the mill crew had to "pick" the oval groove until the rolls would bite. The first turn after a roll change was dreaded. Management was reconciled to the low tonnage produced during this turn because it was considered a necessary evil. When the rolls came out of the mill after a week's run, the oval pass had assumed the general shape of a box groove. The intended oval was for entry into a 90-degree square, but the "lump" which actually entered was something to see, yet this practice persisted for a generation. With roll maintenance handed to your writer's shop, the oval design was altered to a box pass, the square made into a curved bottom edger and from there to the regular smaller ovals and squares. No mention is made about the mill's objections before the new passes were tried, but thereafter the tonnage of the first turn was equal to any. Longer wearing and stronger rolls were used and dressings very materially reduced.

There is satisfaction when betterments are made over former practices or when new units are installed whose performance excels anything done before, but there should not be too much such elation. Generally the right approach is to condemn ourselves for not seeing the obvious long before. It is fitting to close with a quotation, paraphrased for our purpose, from Paul H. Douglas as found in an exchange. "No generation of engineers really finishes the business at hand. Each one unlearns what was false in the preceding generation; each one learns its own truths and adds them on to the ones inherited from the past. Chief engineers and roll designers may climb a peak of achievement and draw their assistants up to it, but these younger men who follow after see other heights they must scale in their own day. And so we move on from generation to generation on a wide and broad horizon, straining to do the tasks we set for ourselves and strengthening our fibre because we do so."

Figure 9 — **Attempt to produce a full contact face between coupling box and roll pod resulted in excessive backlash.**



DISCUSSION

PRESENTED BY

H. A. CARTER, Superintendent Roll Department, Bethlehem Steel Co., Lackawanna, N. Y.

GEORGE A. BROWN, Superintendent Roll Department, Bethlehem Steel Co., Steelton, Pa.

L. J. GOULD, Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

NORMAN C. BYE, Director of Engineering, Henry Disston and Sons, Inc., Philadelphia, Pa.

WILLIAM A. MILLER, Superintendent, John A. Roebling Sons Co., Trenton, N. J.

LOUIS MOSES, Superintendent Rail Mill and Roll Department, Bethlehem Steel Co., Sparrows Point, Md.

H. A. Carter: I would like to ask how the author would figure working diameters on a mill such as our revamped 30-in. continuous billet mill, where every

other stand is a vertical stand and the 6 stands are driven in pairs with three motors, without variable speed. The vertical rolls have but one pass in them, and we have to roll 7 × 6, 6 × 6, 5 × 5, 4 × 4, 5 × 4, and 6 × 5 billets. This meant many roll changes and delays, so we have had to compromise and get an occasional pull or push in order to get tonnage.

The final result is that we now roll all these billets from one layout of vertical rolls and have increased tonnage on this mill from 75 to 110 tons per hour.

Another interesting problem we recently encountered was the rolling of a large zee piling section. This section has a vertical web of about 13 in. long with 7 in. legs. The length of passes in intermediate stand is about 22 in., making it necessary to roll the vertical web at about 32 degrees in the rolls. This created so much end thrust that the finished web was 1/16 to 1/8 in. too thick. The end thrust was so great that the 4 in. spreader bolts were stretched 1/8 in. when checked after the trial rolling.

To overcome this problem, we utilized the blank passes of this three high stand and made bearing collars. This solved the problem but I cannot foretell what the roll life will be.

George A. Brown: I have in mind an experience when changing a box-pass design to diagonal rolling when we tried to lay the passes down keeping the draughts regular. Everybody was happy when the first bar got through without any trouble, and the whistle blew to "Go ahead and roll." But we found we had to juggle our passes by taking some off here and there because we could not otherwise roll the section. So we had to throw away that part of the theory which said to make regular reductions from pass to pass and changed the passes according to the way they would take and deliver the steel.

L. J. Gould: If you were to take ten roll designers and give them the same problem they would come up with ten entirely different solutions, and then ask the chief engineers to supply enough motors to take care of any errors in their calculations. After the theoretical passes are laid out and placed in the mill, with the areas of each pass nicely worked out, the mill man screws down and screws up, and anything that comes out of the final pass remotely resembling what was originally intended to roll is an accident of the "first water."

This may be a slight exaggeration, but the more the author writes and the more private lectures he gives me, the more I am aware that they have many problems. The situation is largely the number of variables which have not been evaluated in terms of physical and mathematical summations, for instance, there is a very simple formula for speed of the bar with respect to the speed of the mill, which is $\frac{\text{LAMBDA}^2}{2} \times \left(\frac{\text{D-1}}{\text{H}^2}\right)$ in which "H" is the opening in the pass and "D" is the diameter of the roll. There is still a little difficulty with this term "LAMBDA." It is actually the angle in radians to the point where the bar is traveling at the same speed as the surface of the roll. There is a very nice differential equation which explains the "LAMBDA." The process is simple enough and you only have to evaluate about four constants. None of us have the faintest idea of the value of these constants. You can see that the problem is simple.

Something, however, can be done about these things and I believe that the roll designers are now attempting it. Most of us can remember when information on roll passes was whispered around and as carefully concealed as the sources of bootleg liquor. Today, the Association of Iron and Steel Engineers roll design group are coming out and publishing their data, stating completely and honestly what they are doing, and as far as they can possibly tell us "why."

In the case of the speed of the bar leaving a mill, which is of so great importance in any continuous rolling, we do not have enough factors to set up an empirical equation or to evaluate constants in a theoretical equation. The spread of the bar is just as confusing as the speed of it. We have few real facts on which we can place a numerical value. It should be the effort of our roll designers to collect their observations in great numbers and to interest research and engineering groups in specific problems.

Mr. Moses, as we all expected, has added here another important contribution to roll design knowledge. The suggestion that all mills of the whole country be tabulated seems to be an excellent one. The members of the AISE Board of Directors should take that subject up.

Norman C. Bye: I am always impressed when hearing about some of the large sections rolled on the tonnage mills. In our tool steel mill, we roll only small sections and some are extremely small. In these sections, we probably roll as many different shapes as a tonnage mill does in their large sections. The same principle as far as filling out the pass or in the entering or roll surface characteristics applies to the small sections as applies to the large sections. There is no universal rule which designates the one best procedure.

Even in the same mill, different rollers have their favorite set-ups to accomplish the same end results. I believe a program of compiling data on actual installations and operations as suggested by Mr. Moses will prove a great benefit in crystallizing this information for practical use and I hope the AISE takes action on Mr. Moses' suggestion.

William A. Miller: I would like to ask a question with regard to the water Mr. Moses talked about doing without, on the rolling of heavy sections in blooming mills. In a number of cases we find that we get much better results by using more water, as we are able to increase the roll life and keep our passes in much better condition.

Louis Moses: Mr. Gould admirably states the author's objectives in attempting evaluation of experience. Each one of the ten roll designers could justify his individual finding and be correct, notwithstanding difference from the others. Each answer would be based upon acquired skill in a few or many rolled products with applications of some phases to larger or smaller mills as the case may demand. To this would be added ingenuity, daring and a dash of imagination. Collectively the ten would provide the means for resolution of a common denominator which would be pretty close to the desired goal. In this regard they would be far closer than are engineers in agreeing on the values of

the constants making LAMBDA. The roll designer and the engineer thus have a common objective with everyone benefiting from the sharing of significant knowledge. At this time could the query be raised on whether or not the topic of emerging bar speeds would furnish a clue to the finding of the much sought after neutral point of bar-roll speed?

Reference is made to the manner in which mill rollers adjust rolls after the careful work of the designer is expended. After all there is a very low "factor of safety" allowance in a set of grooves for such purpose, there must be some. Perhaps the action of the rollers in altering settings of the first stand of a continuous mill is in mind. He arbitrarily must open his rolls when rolling rimmed steel because such material runs into elongation to the detriment of filling up grooves. Similarly, he must close up to hold back stock when rolling the denser killed steels which would otherwise tend to overfill the passes or perhaps cobble the mill. Few except mill operators are aware of this, and incredulity is sometimes expressed by otherwise well informed people when first observing the practice.

Mr. Brown's experience shows that previously held views on drafting diagonally constructed grooves were in error at some location. He does not describe the difficulty or means of its correction. However, the experience taught that the total work performed on some groove or grooves is conditioned by the relative amounts which are possible to take simultaneously across the two axes, either alone or in combination as the case may be.

As to Mr. Carter's vertical-horizontal roll arrangement on his 30 in. continuous mill, it is believed that groove construction of the new arrangement paralleled the former all-horizontal stands which employed bar twisting. It is also understood that the original roll diameters did not behave as desired, requiring altered pitching because the bar was filling the grooves well up toward the collar diameters. He does not mention the highly interesting lowering of power consumption when twisting was eliminated, this in itself being an indication of changed conditions in the roll-gap. These things had to be learned because there was no former experience to draw upon. The only comment to be made on arranging the vertical roll grooves to accommodate the gamut of sizes he mentions is that they now are probably free from groove wall influences, and that constants can be figured from groove-bottom diameters. Mr. Carter has provided us with a point to consider when designing or revamping rolls for such mills.

In regard to Mr. Miller's question on whether greater amounts of water would be more beneficial to his blooming mill rolls instead of a lessened volume as could be implied from the paper. This cannot be answered offhand, a controlled experiment being required to find trends. Only a few thoughts occur. The idea was had of installing an automatic valve which would operate with the roll reversals in direction, shutting off at the entering side and applying water to the delivery side. Complications are present in arranging piping to clear falling ingot scrap, and it has been more or less permanently shelved. At another place the operators advanced the thought that the first passes taken on an ingot should be on dry rolls with trials at the time reported on as being rough on rolls. Then in the tandem rolling of large ingots a previously successful roll material requires one-half heavier dressings over those had with single ingot rolling. The exposure to the heat of doubled lineal feet of ingot and rolled product causes greater depths of fire-cracking. It could be that the added imput of heat actually raises the roll-surface temperature well over that occurring with former practice. Regardless of the present quantity of water, or more of it if it was possible to get more, a wider range of flash generated temperature must be quenched back in a shorter time interval, accounting for the increase in roll damage. Current attempts to meet this last named situation are by means of alternative roll metals.

Mr. Bye's observations are based on his experience with small mills. His roll people have developed a highly specialized technique in rolling tool and alloy steels. Such alloys, especially in the form of small and intricate sections, tend to spread more and generally are less amenable to rolling deformations than are the carbon grades.

Drawing a line between experience and theory is a highly difficult matter with the author's pencil confessedly not sharp enough to draw it. The nearest attempt would say that when one arrangement of passes, or stands, or what have you, works better than others the matters involved become subject to analysis. If basic facts are disclosed these become theory as based on experience and can thus be extended to still other applications. No individual, regardless of how wide his experience has been, can embrace more than a fraction of the sum total possessed by the industry as a whole. If our literature can be enriched by only a portion, many a project could be approached more confidently.

Annual Spring Conference

DETROIT, MICHIGAN

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Ventilation of Steel Mill Motors and Motor Rooms

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. . . . motor maintenance can be reduced by making sure that makeup air is clean . . . .

▲ THE application of ventilating systems to supply clean air for the motors, generators and control devices for modern steel mills has become so general that the question is no longer whether or not a ventilating system is necessary, but rather what type system should be installed. The basic requirements of the system are to provide for the circulation of clean air through the machines to remove losses and to remove these losses from the motor room, and to maintain a clean cool room in order to reduce maintenance on the electrical machines and their controls. Local conditions must be considered in selecting the particular type of ventilation system to be used.

GENERAL

Ventilation systems may be either of two general types, recirculating or non-recirculating. In the recirculating system, air is taken from the motor room, passed through the machines, cooled and returned to the motor room. In the non-recirculating system, outdoor air is filtered, passed through the machines and discharged outside the motor room.

Systems may be further classified as downdraft or updraft, depending on the direction of air flow through the machines. Recirculating ventilation systems for motor rooms are almost without exception downdraft systems. Non-recirculating systems may be either downdraft or updraft, the downdraft system being preferable for motor rooms. A downdraft system will always result in the coolest motor room.

Any ventilation system should be designed so only filtered air is supplied the system and so any leakage from the system is outward. This requires a positive system pressure at all points where leakage may occur. A negative system pressure is permissible only in basements or other areas which can be positively sealed against entrance of outside air.

A positive system pressure is maintained by supplying makeup air to compensate for leakage from the system. A makeup supply equivalent to 10 per cent of the total quantity of air circulated through the machines is generally sufficient. A tight motor room construction is essential.

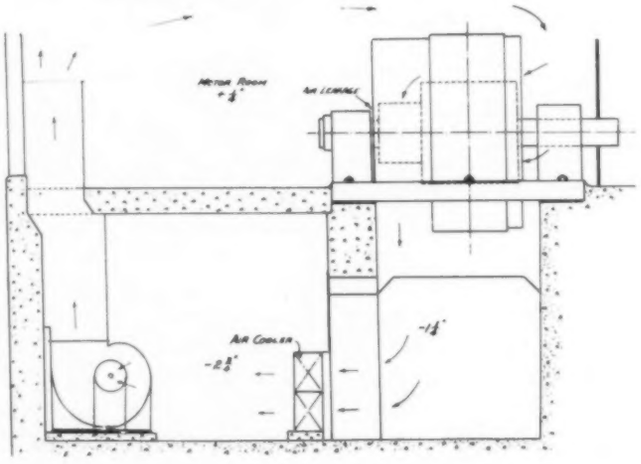
Normal steel mill practice is to circulate 120 cfm air per kw loss through motors and generators.

CARBON DUST

The question is frequently raised as to the effect of carbon dust from d-c machine brushes. Air flow through a machine should be in at the drive end and out at the commutator end to avoid carrying the dust directly into the machine windings. In most systems there will be a point below the machines where the air velocity is 400 fpm or less and the carbon dust will settle out, and may be swept up.

It may be argued that any carbon dust will be carried outside a non-recirculating ventilation system, and that type ventilation is therefore preferable. However, analyses made of the dirt collected in a recir-

Figure 1 — Schematic arrangement of recirculation ventilation system for drive motor located in motor room. The makeup air required is put into the motor room and the figures indicate air pressure relative to mill building pressure in inches of water.



culating system have almost invariably shown that the bulk of the dirt is from outside the motor room and that carbon dust is a negligible percentage.

HUMIDITY

Recent studies have shown that humidity may be a factor in brush life. Studies have shown that the minimum humidity for satisfactory brush life is approximately 20 per cent relative humidity at normal room temperature or about 0.15 grams per cubic foot of air. Brush trouble may be experienced at lower humidity.

The best overall operation is apparently between 40 and 60 per cent relative humidity. However, a study of a psychrometric chart will show that, in a recirculating system, even very low temperature cooling water will not reduce the humidity to the point where trouble will be experienced. Therefore humidification should not be necessary except in very dry areas.

Humidification, if necessary, can best be accomplished by a washer spray. This may be ahead of an oil film filter, but should be behind an electric precipitation filter to guard against moisture carryover to the filter which might short out the ionizer elements.

In any system, space heaters should be provided underneath motors of 300-hp rating or larger, or generators of 250-kw rating or larger to prevent condensation in the machine during shutdown periods.

RECIRCULATING VENTILATION SYSTEMS

A recirculating ventilation system has some operational advantages over a non-recirculating system and may require less space for installation. The air coolers can usually be installed under the machines, or in the motor room basement, and usually require no additional space over that required for a non-recirculating system. Since the air filter need only be large enough to supply makeup air, it may only be one-tenth the size of the filter for a non-recirculating system, with consequent reduction in space requirements and maintenance time.

A recirculating system permits year round control of motor room temperature by regulation of water flow through the air cooler. Motor room temperatures are reduced in summer. In winter machine losses may be retained in the system by cutting off water flow through the coolers and thereby reducing motor room heating requirements.

In a recirculating system, a make-up air filter and supply fan should be provided to compensate for air leakage from the system and to maintain a positive pressure in the room. This makeup and supply should be equivalent to about 10 per cent of the total cu ft air circulated through the machines. Air may be bled from a recirculating system to ventilate auxiliary mill drive motors, such as screw-downs, manipulators, etc., or for drive motors where it is not convenient to recirculate the air. In this case the filter capacity should be based on 10 per cent of the total air circulated, plus the amount bled from the system.

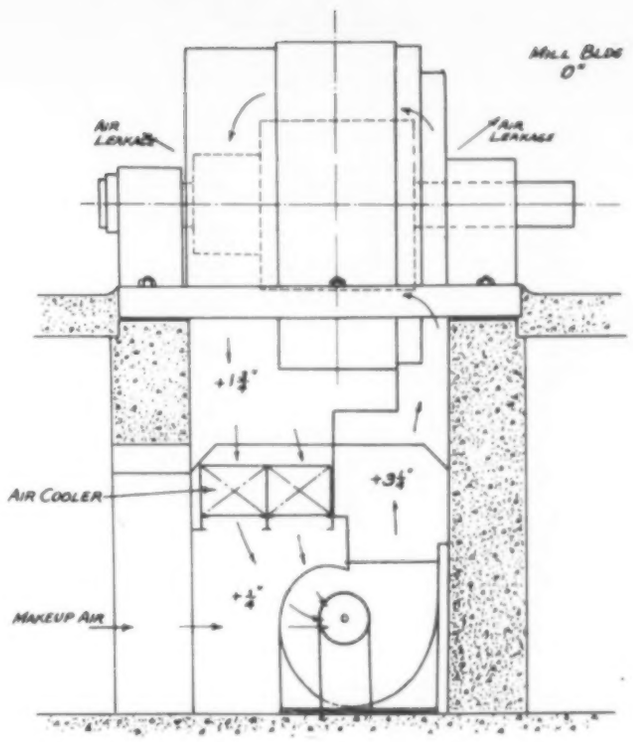


Figure 2 — Schematic arrangement shows recirculation ventilation system for a drive motor located in the mill area. Note that air leakage is from motor to mill.

Small, tight systems have been operated satisfactorily without makeup air supply. This has proven advantageous for isolated motors located in the mill where the cooler and fan may be located in a pit underneath the motor. Such systems should be studied, however, to see that air leakage paths, which would introduce foreign matter, are eliminated insofar as possible. Makeup air should be supplied to the isolated motors if at all possible, otherwise the system balance will usually result in air leaking out one end cover, and being replaced—with dirt additions—by leakage in at the other end cover. Such leakage might be permissible in some cases, very bad in others—such as around a cold mill where palm oil is present.

Figure 1 shows a schematic arrangement for ventilating a motor located in a motor room. Figure 2 shows a schematic arrangement for ventilating a motor located in the mill area. Note that in both cases all points at which air leakage can occur from the system are at a positive pressure with regard to the mill area. In the case of a drive located in the motor room, makeup air should be supplied to the motor room maintaining a positive pressure of about ¼ in. in the room. In the case of the motor located in the mill area, makeup air should be supplied at the fan inlet. This will maintain a positive pressure in both end covers of the motor.

With further reference to Figure 2, assume that makeup air is supplied so the pressure is ¼ in. at the fan discharge. Pressures as indicated in Figure 2 would then be 3 in. less. There would still be a slight leakage from the drive end of the motor, but at the commutator end there would be a negative pressure of 1¼ in., and air leakage would be into the motor. In a cold mill with palm oil fumes present, this air leakage might cause

serious difficulties within a relatively short period of time.

The cooling water requirements for a recirculating system will be approximately 0.8 gpm per kw loss for a 10 degree F differential between cold water and cooled air, or about 0.5 gpm per kw loss for a 25 degree F differential. These figures may vary somewhat with the cooler design required to fit a particular installation. The water used for cooling the recirculating air may be used in the mill after passing through the coolers. However, any system should be designed with a bypass so the excess of mill requirements over cooler requirements may be met. This bypass is especially important in winter operation in which it may be desirable to cut off the water to the coolers entirely in order to retain machine losses within the motor room, to keep room temperatures high enough for comfort of personnel. In this connection it may be noted that the station temperature may be controlled by suitable control of water flow through the coolers. This may be done automatically with thermostatically operated valves or as is more common, with manual control.

NON-RECIRCULATING SYSTEMS

A non-recirculating system design is necessary for those mills in which an adequate supply of cooling water is not available. In these systems, motor-room summer temperatures will be at least equal to outdoor temperatures unless air washers are used with resulting evaporating cooling. Most non-recirculating systems may be arranged with suitable louvers in the air discharge ducts so the air may be recirculated in winter, and machine losses conserved for room heating purposes. Recirculation of the air supplied any motors in the mill area is generally impossible.

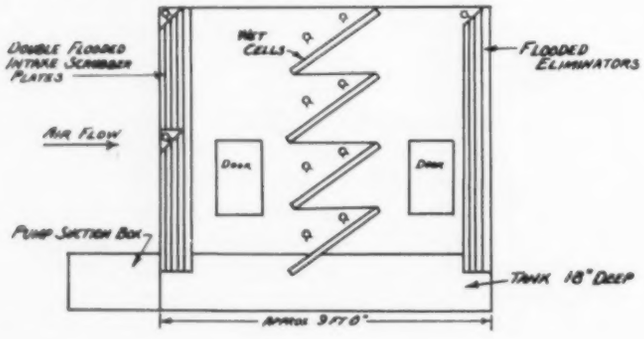
In a non-recirculating system the air should be supplied directly to the motor room with secondary fans to take the air from the motor room and force it through the machines.

A non-recirculating system for a motor located within the motor room may be designed like Figure 1 omitting the air cooler and providing a suitable interlocked damper arrangement at the top of the fan discharge air duct so that the air may be either blown outside the motor room or returned to the motor room.

In the case of a motor in the mill, the air is blown up into the drive end of the motor and out through suitable louvers in the commutator end cover.

The air filter capactiy for a non-recirculating system should be based on the total air requirement for the machines, plus 10 per cent to allow for air leakage from the system.

Figure 3 — The wet air washer was designed for steel mill application. The standard washer does not have intake scrubber plates (L=6 ft 6 in.). For extreme dirt concentrations, an eliminator type inlet baffle and a bank of spray nozzles are placed ahead of the intake scrubber plates (L=12 ft).



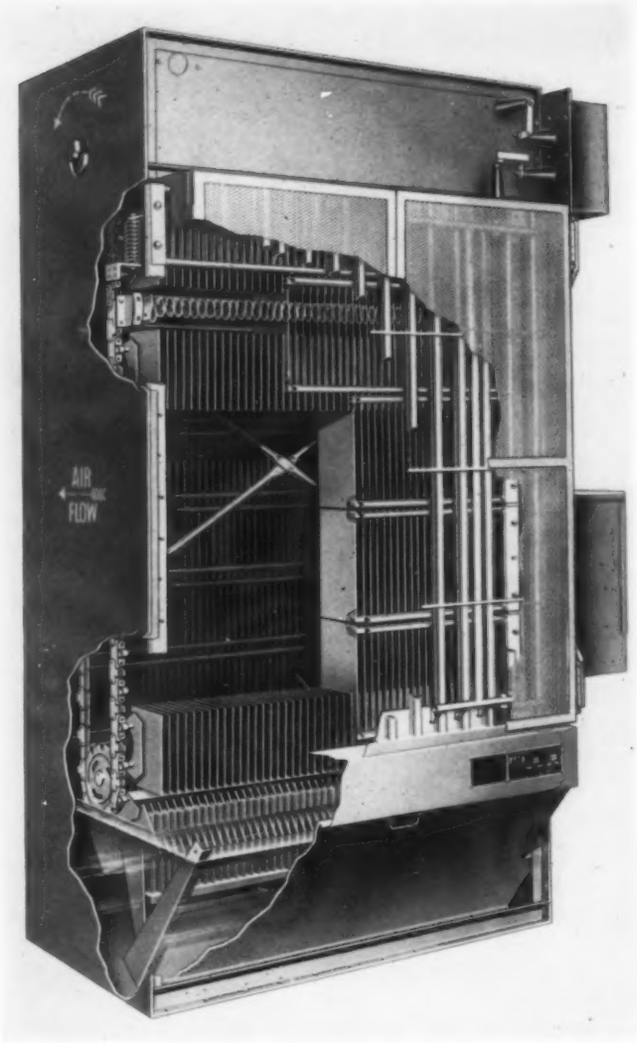


Figure 4 — This electric precipitator is self-cleaning.

FANS

Fans for steel mill ventilating service should be rugged construction and should have a non-overloading characteristic. If for any reason the pressure against which the fan operates should change, the volume of air delivered will vary and under such conditions, the driving motors should not be overloaded. An example of such a circumstance is that of two or more fans operating in parallel. If one fan is turned off for any reason, the other will deliver more air than it normally does against a lower pressure. The fan should have a drooping volume characteristic in order to prevent excessive increase in volume delivered, and a flat horsepower input curve to prevent overloading of the fan motor.

Backdraft dampers should be furnished on fans which operate in parallel. This prevents recirculation of air through a fan which is shut down for any reason, and in some applications may permit operation at a reduced schedule with the fan or fans remaining in service.

The makeup or supply air fans for either recirculating or non-recirculating systems are generally specified to overcome the pressure drop through the air filter, plus ¼ in. to maintain a positive pressure within the system. This makes a total pressure rating of ½ to ¾ in. water required. The fans for the drive motors are specified to force the air through the machine, the cooler, if required, and any air ducts.

AIR FILTERS

Air filters for use in steel mill ventilating systems are of three general types, the travelling screen oil film filter, the air washer, or the electrical precipitation filter. Due to the heavy dirt concentrations frequently encountered in steel mills, it is good practice to use filters 25 per cent larger than the manufacturers standard listed rating.

Oil film or electronic precipitation filters will usually have the advantages of less floor space required, lighter weight, and less danger of freezing than an air washer. An air washer will remove chemical fumes and has the advantage of evaporative cooling in a non-recirculating system. An air washer is absolutely fireproof, but this advantage has been offset to some extent by the fireproof adhesives which have been used in other filters in recent years.

The cleaning efficiency of an air washer is in general between that of an oil film filter and that of an electrical precipitation type filter. An electrical precipitation type filter is best for smoke removal where particle sizes are small. A "roughing filter" may be desirable ahead of an electrical precipitation type filter in some applications where dirt concentrations are excessive in order to reduce maintenance on the electrical filter. I do not know of any installation to date where this has been done. Generally heavy dirt can be dropped out ahead of the filter, or removed by the filter satisfactorily, if the air velocity immediately ahead of the filter can be reduced to less than 400 fpm.

It is possible that some sweating could be experienced due to excessive humidity with an air washer, but we have heard of no complaint on any installation to date.

With an air washer, some water must be discharged from the washer tank to the sewer at all times to prevent acid concentration buildup in the tank. The wastage will average about 2 gallons per minute per 1000 cfm capacity.

The sketch in Figure 3 shows an air washer suitable for the dirt concentrations experienced in steel mill applications. For extreme dirt conditions, an additional eliminator type inlet baffle and bank of spray nozzles may be placed ahead of the intake scrubber plates.

Figure 4 shows an electrical precipitation type filter designed to be self cleaning. Sludge is removed in the same way as with the travelling screen oil film filter.

COST OF SYSTEMS

Figure 5 gives a relative cost comparison for ventilation systems. All relative costs are based on a recirculating system with an oil film air filter and a 10 degree F differential temperature between cool water and cool air. All systems are downdraft and include equipment for a makeup air supply equal to 10 per cent of the total air flow through machines. Cost figures include the cost of fans, filter, and cooler for recirculating systems, but do not include ductwork, piping or installation.

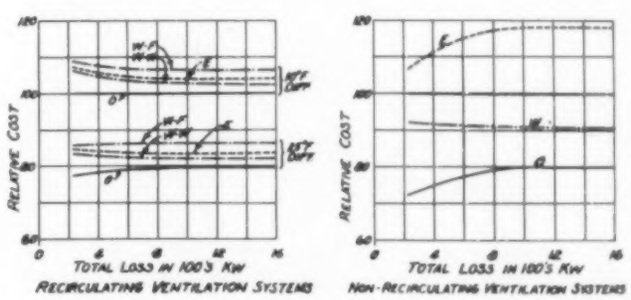
The relatively high cost of an air washer system in areas where freezing temperatures are experienced is due to the necessity of making the air washer about double the size required for makeup requirements in order to permit sufficient recirculation in cold weather to prevent freezing. In the non-recirculating system it has been assumed that sufficient air can be recirculated to prevent freezing. If this is not the case, then steam heating coils must be provided.

MAINTENANCE

Filter maintenance is probably the largest factor in any ventilating system, especially in a non-recirculating system where the filter bank may be extremely large. The dirt which accumulates in an air washer tank may be flushed directly to the sewer, and for this reason the air washer has found considerable favor with maintenance men.

The curse of the oil film or electrical precipitation filter from the maintenance standpoint has been the necessity of raking the sludge out of a tank at the bottom of the filter. This curse has been removed in some recent installations by arranging to flush all sludge to a cleaning system at a lower elevation. This system is illustrated in Figure 6. All cleaning and supplying of makeup adhesives is done at the cleaning system. All that is necessary to do at the filter proper is to manipulate the necessary valves. This is particularly advantageous in those installations where space is at a premium, and it becomes desirable to locate the filter in a penthouse on the motor room roof. The cost of the cleaning equipment will add from 10 to 20 per cent to the cost of the system, the percentage being less for large systems.

Figure 5 — Data for curve "O" is for traveling screen, self-cleaning oil film air filter; "E" represents electric precipitation type air filters; "W-W" is air washer installed in non-freezing area; and "W-F" is for air washer installed where freezing temperatures may occur.



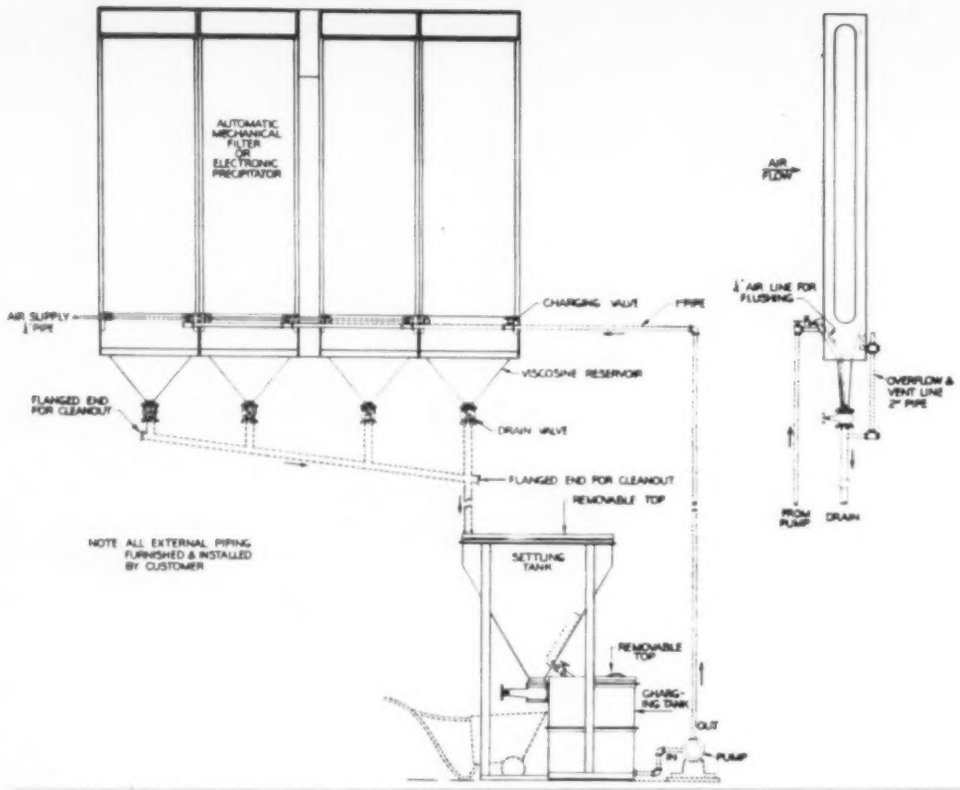


Figure 6 — Dirt picked up may be removed by flushing sludge to a lower cleaning system.

With regard to the cleaning systems, we are advised that a system using oil filters of the cartridge type could be used. These systems have proven very satisfactory in office buildings, theaters, etc., but the manufacturer hesitates to recommend them for steel mills or other locations where dust concentrations are extremely heavy. The system which has been installed in some recent jobs is a settling tank or sedimentation system where the sludge is flushed into a large tank. After allowing the sludge to settle out, the adhesive is decanted off the top and the sludge is then flushed out to the sewer or drained to a suitable receptacle.

In a recirculating system, air coolers must also be maintained. In any case the water supplied must be strained in order to eliminate any large particles which might plug water lines or tubes. Since the water which is used for the air coolers may be used for the mills, this imposes no additional hardship as foreign matter which would plug the coolers would also plug mill lines.

Fouling of air cooler tubes may be of any one of three general types: mud, slime, or scale.

Mud deposits in a cooler may often be removed by opening the supply valves wide enough to force a large flow of water through the tubes with the resulting turbulence carrying the mud out of the system. Some considerable success has also been achieved by connecting a compressed air line to the inlet side of the cooler and creating turbulence within the cooler by periodically admitting a quantity of air.

Slime deposits can frequently be removed by chlorination of the cooling water at intervals. In other cases it may be necessary to remove the cover plates at the ends of the coolers and mechanically remove the slime. This can be done with brushes or by forcing rubber plugs through the tubes with compressed air.

Scale deposits in the cooler tubes must be removed by a scraper type cleaning plug.

Carbon dust deposits may build up on the fins on the outside of the cooler tubes. In some cases water will remove such deposits, in others it may be necessary to use steam. A temporary baffle may be used to prevent water or steam being carried into the machine windings during the cleaning operation. When cleaning is started, either water or steam should be passed through the cooler in a direction opposite to normal air flow, since the heaviest dirt concentration will be at the air inlet side of the cooler, and should be forced out of and not further into the tube bank.

Probably the best recommendation that can be given for estimating the amount of cooler maintenance that will be required is to consult the operators of the nearest power station with regard to the amount of maintenance required for their steam condensers. It is quite safe to say that the maintenance required for the air coolers will be less than that required for the steam condensers, particularly in the case of scale. The water temperature rise through the air cooler will be considerably less than that through the steam condenser, and scale deposits are usually a function of water temperature rise.

In closing it is well to note that no other factor in steel mill ventilation is as important as good maintenance. The best ventilation system is no better than the maintenance given it. This maintenance should not only include regular and thorough cleaning of filters and air coolers, but should also be extended to regular inspection of the overall system. Tight buildings are essential, and it is desirable to eliminate all windows, especially those with movable sash. Closing of doors must be rigidly enforced. It is of little value to install an expensive ventilation system if openings are left through which air may enter without being filtered, or if the maintenance is such that the air cleaning equipment cannot function properly.

OPERATING THE WORLD'S FASTEST MILL

. . . . a number of novel and unusual design features were first installed on this mill which is rated the fastest mill in the world . . . .

OPERATIONS

By J. R. POWELL

Superintendent, Tin Plate Dept.

Jones & Laughlin Steel Corp.

Aliquippa, Pa.

▲ WHENEVER a mill is constructed that embodies a number of new principles, and is engineered to exceed previously built mills in performance, in speed, production or flexibility, it is inevitable that there will be a great deal of inaccurate discussion and data developed from which erroneous deductions are made as to the operating limits and abilities of the mill. In the paper here, an attempt will be made to correct some of these impressions and afford some information about the construction and operation of the mill.

The 42-in., five-stand, tandem mill at Aliquippa works of Jones and Laughlin Steel Corp. started operations in early October of 1947, to be used entirely for the production of tin plate and its allied products. It was planned so that the mill would be capable of rolling the entire range of tin plate gages in widths up to 36 in. at speeds up to 6,000 fpm. With the high speeds that were planned, it was self-evident that larger coils were necessary than had previously been made by this company to take advantage of this factor. Since coils larger than 7,000 lb were impractical due to limitations in equipment for producing hot rolled bands, construction of a welder suitable for welding coils so that they might be rolled at high speeds was a necessary first consideration. Such a welder was built as an integral part of the new continuous pickler built in conjunction with the tandem mill. With the aid of this welder, coils with an inside diameter of 16 in., and an outside diameter up to 80 in. was made possible. Due to other limitations, this outside diameter has been held to 72 in., allowing a maximum coil weighing approximately 1,100 lb per in. of width. Since we were insistent that all coils were to be handled with a minimum of damage and a maximum of safety, pallet type conveyors were used in both the pickler and tandem mill installations. Extremely heavy construction was necessary with the heavy coils involved. This same heavy construction was followed out in design of all auxiliary equipment and safety guards, to eliminate safety hazards as well as reduce maintenance to a minimum.

Before passing on to a detailed description of the equipment, we would like to point out that in all this construction the matter of employee safety was at all times given primary consideration. The hazards of light gage and high speeds were so great that it was felt that the most effective guarding was a necessity of the first order. This concern had to go necessarily beyond the mechanical and electrical equipment and become of equally great concern in selection of crew members and other personnel involved in the operation of the mill. Better than average alertness on the part of individuals, and coordination between the operators had to be taken into account in building up the crews. Even after the original crews were selected, it was necessary to make changes simply because some individual was proven incapable of keeping up to the standards required. It was quickly learned that injuries, fortunately mostly minor ones, came repeatedly to certain individuals, and almost without exception to those who had shown ineptness in their particular part

Figure 1 — Steel strip is shown here being lifted from the looping pit and entering the first of four pickle tanks on the new continuous pickle line at the Aliquippa Works, Jones & Laughlin Steel Corp.

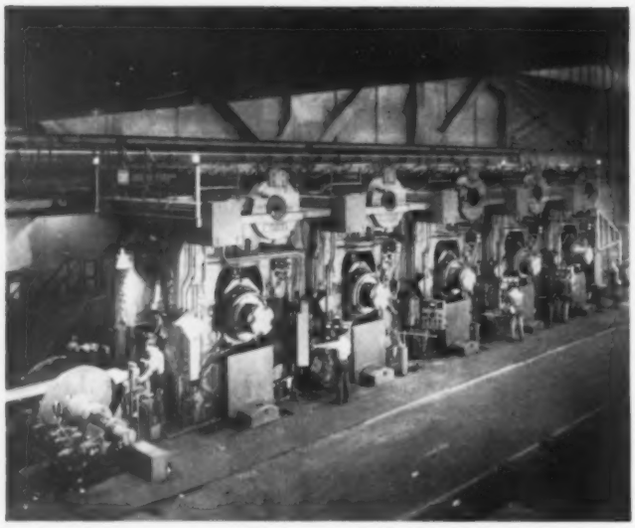


Figure 2 — Production on this 5-stand tandem mill has exceeded expectations and additional finishing facilities are now being installed to utilize the full capacity of the mill.

Figure 3 — The coil at the left is lifted and positioned on the feed reel by the hydraulic apparatus operated by the feeder in the foreground.

of the operation. We now feel that the greatest part of this is behind us, but constant attention will always be required to maintain a high degree of efficiency and cooperation.

The hot rolled pickled coils are placed on a driven pallet conveyor which discharges on to a ramp into the feed reel of the mill. Coil stop is provided in the ramp ahead of the feed reel, and driven spinner rolls are used to rotate the coil to the desired feeding position. The side discs for positioning the coil are 80 in. in diameter and faced with bronze. This was found necessary due to the galling on the previously used steel faces. Hoist rollers for positioning the coil vertically were chrome plated, again in an effort to avoid galling and damaging of the strip. Mill housings are of extremely heavy construction, weighing approximately 120 tons each finished. The pillars are 30 x 38 in. and mill centers are 13½ ft. No. 1 stand is driven with a single 1,750 hp motor. No. 2 stand is driven by double armature direct drive through gears with a total of 3,500 hp. No. 3 stand is driven by single armature motors independently driving the top and bottom work rolls through 1/1.525 ratio gears, a total of 3,500 hp. No. 4 stand is the same as No. 3 except the gear ratio is ½. Again the total horsepower is 3,500. No. 5 stand is driven with separate double armatures, each totaling 2,000 hp or a total of 4,000 hp for the stand. This stand is also driven through a ½ ratio gear. The tension or delivery reel is powered with a double armature direct drive totaling 600 hp. The total horsepower of all drive motors is 16,800.

Due to the geographical situation and to the wide rundown on both back-up and work rolls, the spindles are approximately ten feet overall. This, of course, reduces the angularity and the wear on spindles.

Back-up rolls start at 53 in. diam and are run down to 46 in. with a 42 in. face. Back-ups are all ground flat with a 4 in. chamfer on each side ground 0.125 in. deep. Iron work rolls are used in No. 1 and No. 2 stands with a 0.0015 crown top and bottom. Steel rolls are used in No. 3, 4, 5 and are ground flat.

Flooded oil type back-up roll bearings are used, having a capacity of three million pounds. Although no serious trouble has been experienced with either back-up rolls or bearings, it has been found necessary to increase the original bearing clearance from 0.020 to 0.030 in. and decrease the oil viscosity from the original of 1,800 down to 1,300. It may be possible that this viscosity will again be lowered in the future, but at current operating speeds we have found this viscosity to be satisfactory. The oil flow per bearing was measured in relation to speed, and it was found to follow a rather straight slope. At 3,500 fpm the bearing took approximately 27 gpm and at 4,500 fpm 33 gpm. In starting up the mill and advancing to the higher speed ranges, temperature readings indicated that an insufficient amount of oil was being delivered. The entry orifices were enlarged to approximately double the original capacity and sufficient flow has resulted since that time. Indicating and recording instruments are used on the oil at all ten back-up roll bearings. The entering oil temperature is held at 100 F. Oil leaving the bearing ranges 130 to 150 F depending upon the position of the bearing in the mill and the speed of operation. Experience has taught us that temperatures much in excess of 150 F are indicative of trouble.

Work roll bearings are four row pin roller type. Original bearing clearances on some of these work roll bearings was only 0.006 in. Due to heat pick-up, we found it necessary to change all the work roll bearings to 0.012 in. clearance. This same difficulty was encountered on back-up thrust bearings and clearances had to be increased as well.

Carefully balanced gears are a definite requirement for successful high speed operation.

The screw-downs are equipped with 75 hp motors, 400/1 ratio, with Ward Leonard control and rotating type regulators for load limit control. It is interesting to note that up to this time we have never jammed a screw.

Filtered water is used throughout the mill for cooling. Although the mill cooling water was first set up for

80 psi pressure, it was quickly learned that this was insufficient and we can now go up to 150 psi pressure since the installation of new pumping equipment.

Duck bill sprays staggered to provide even distribution are used throughout the mill. No. 1 stand is provided with sprays top and bottom on the delivery side. No. 2 and 3 stands have sprays top and bottom on entry and delivery side of mill. No. 4 and 5 are equipped with sprays on top and bottom of the delivery side and the bottom only of the entry side. We try to keep the use of entry sprays to a minimum, but leave their use to the roller's discretion.

The sprays on No. 4 and 5 stands are made up with split headers in order to afford the roller a maximum flexibility in controlling shape while the mill is being warmed up after roll changes. This, of course, also facilitates ease of control for shape conditions. Water consumption varies from 3,000 to 4,000 gpm depending on rolling conditions.

Rolling lubricant on this mill consists of a mixture of palm oil and water, usually with about five parts of water to one part of palm oil. This ratio can be varied at will with changing conditions, but under average circumstances the above mix is used. The mixture of palm oil and water is made up by proportioning pumps feeding into a small thirty gallon mixing tank in which the temperature is held at approximately 170 F to minimize separation. The small 30 gallon tank is used in order to make a rapid change in the palm oil-water mixture if it became necessary due to mill or steel conditions.

Originally a total of 42 individual piston pumps took the mixture from a loop manifold under the mill and carried it to the point of application, a distance of approximately 30 ft. Due to the fact that the oil-water mixture began separating in about 15 seconds, and the travel from the loop manifold to the point of application required approximately 30 seconds, it was obvious that difficulty was encountered. Further the pulsating effect of the piston pumps resulted in an uneven linear distribution of the mixture. To eliminate these difficulties we changed to four rotary pumps, and changed the manifold loop so that the distance from the loop to the point of application was only about three feet. A three-way, air-operated valve is used so that circulation of the mixture is continual even when the mill is not operating. The speed of the pumps is proportionate to the speed of the roll. In this manner the amount of palm oil applied per foot of strip rolled remains fairly constant.

The rolling lubricant is applied directly across the top of the strip with flat atomizing nozzles with 0.062 in. orifices, and is spread across the full surface of the strip with a spreader roll which rides the strip. For bottom application the sprays are directed between the strip and the tensiometer roll which acts as a spreading roll.

The cooling water and rolling lubricant is carried in a trough under the mill to a sump from which it is pumped to three overhead skimming tanks where the palm oil and water are separated. By taking this mixture entirely out of the mill building we have found it facilitates cleanliness in the mill area.

Although in our opinion the gauge spread on our hot

Figure 4 — Safety guards completely protect the operator from strip flying in case of break at tension reel.

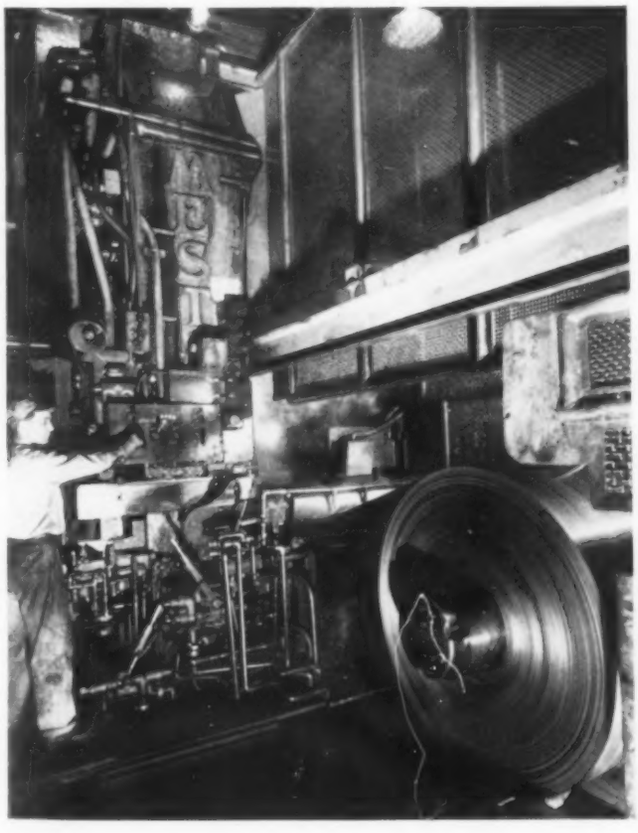


Figure 5 — One lubricating system for the backup roll bearings has been found satisfactory for the operation of this mill.

rolled bands is quite satisfactory, we have installed a micrometer between No. 1 and 2 stands to pick up gauge differences leaving No. 1 and make immediate compensation for them, as well as affording the operator an opportunity to iron out any variation that might arise by changing conditions on No. 1 stand. We have found this to be a step in the right direction and we are making further improvements by additional range of control. Finish gauge is controlled by the use of an X-ray gauge. Operating experience has shown us that a mechanical micrometer is unsatisfactory for speeds in excess of 4,000 fpm. Minometer pencils are used to measure X-ray radiation in the delivery end of the mill. Determinations made to date have indicated definitely that sufficient protection is afforded the operator and that there is no hazard involved.

On most steel grades the gauge of the hot band is 0.090 in. On some of the more difficult rolling grades this gauge has been dropped to 0.084 in. and on bessemer to 0.080 in.

Threading speed on this mill is 600 fpm. With the exception of bessemer steel, over 90 per cent of the welds are rolled at top speed. Although weld breakage is currently running three to four per cent, we are sure that this figure can be improved. Since it is extremely difficult to see the weld in normal assorting or inspection, we installed a punch at the pickle line in order that the weld area might be thrown out by pin hole detectors at our shears. This was purely for customer protection since inclusion of these welds in our prime material caused difficulty in their plants.

It is obvious that breaks at the relatively high operating speeds we are using will cause a severe wreck. In order to forestall any possibility of the strip doubling back over between the top work and back-up rolls, hydraulically operated cobble guards have been installed. These we have found most effective, in fact a necessity when high speed rolling.

Although we have actually operated the mill at speeds well in excess of 6,000 fpm, normal operating speed is currently between 4,500 and 5,000 fpm, depending on gauge, type of steel, quality of steel, and other operating conditions.

To afford the normal control for various steel grades, IR drop compensation is available from the operator's control panel.

We are the first to admit that we still have a great deal to learn about the operation of this mill at high speeds. The individual generator drives and flexibility of control that have been built in as an integral part of the mill afford a wide range in which to work. Many phenomena evidenced at high speeds are not thoroughly understood, and continual study and trial will be required for some time before the full capacities of the mill will be realized.

Steam generated in rolling is exhausted from the mill building by means of down-draft to a large subterranean fume tunnel. The fumes are drawn down through this tunnel by means of two 80,000 cfm fans and discharged outside the building.

Fire protection in the various oil cellars is furnished by a four-ton automatic system. Proper warning systems are installed so that personnel is given time to vacate areas before the system is tripped.

Due to the extreme high speed of delivery end, the hazard caused by strip flying at the tension reel in case of break, a large wire mesh guard is placed over the tension reel. An air-operated gate opens to expose the tension reel to eject a coil on to delivery ramp, but is kept closed at all times during operation of the mill. We might point out here that normally we use hydraulic operation wherever possible in order to afford the greatest protection to the operators.

CONTROL

By GEORGE A. KAUFMAN
Chief Electrical Engineer
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

▲ DURING the early months of operation of this mill, some difficulty was experienced in the proper application of palm oil to the strip, particularly during the accelerating period. For instance, too much oil on the strip going into No. 4 Stand would cause a momentary loop to form between Stands No. 4 and No. 5. This loop, formed by a momentary higher rate of reduction coming out of No. 4 Stand and the resulting loss of tension, caused considerable trouble in broken strip and marked rolls. It was during this period of faulty operation that great benefit was derived from the IR drop compensation. The instant adjustment of percentage compensation on each stand control cabinet during rolling was found invaluable. To correct the above difficulty, the percentage compensation was lowered on Stand No. 4 and raised on Stand No. 5 during the accelerating period. Excellent operating results have been obtained by using a tapered IR compensation setup such as No. 1—0 to 10, No. 2—0 to 20, No. 3—0 to 30, No. 4—40 to 50, with the amount of compensation on the last stand varying from 30 to 75 per cent depending on type of material being rolled.

Another condition observed during early operations was the effect of unequal distribution of palm oil between top to bottom of strip. The rollers soon learned that by observing the differential load balance meter on the individual work roll drives, an indication of palm oil balance was given. For example, excess palm oil on top of strip to that on the bottom would cause greater load indication on bottom roll to that on the top roll. With proper adjustment of palm oil this load balance can be brought more in line.

It can be seen from the above that the big problem of proper application of palm oil was made much easier by reason of meter readings indicating regulator performance.

In the earlier months of operation it was the opinion of many that the load balance between top and bottom work rolls on Stands No. 3, No. 4 and No. 5 should be held nearly perfect. It was also noticed during this same period that scratches occasionally appeared on the surface of the strip, particularly so when rolling the harder grades of steel. These scratches seemed to

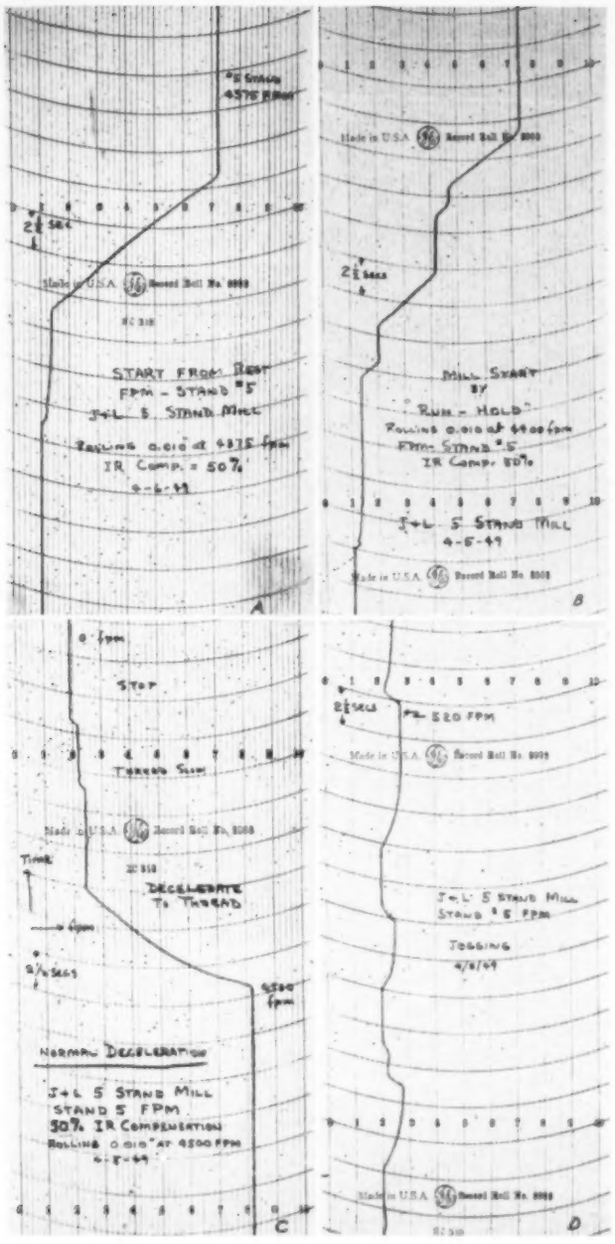
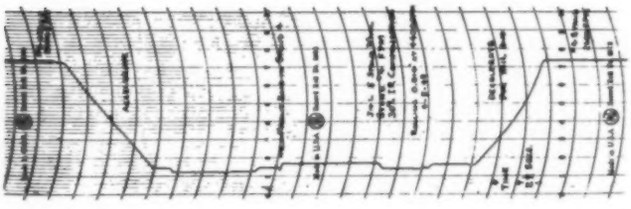


Figure 6 — These four charts show acceleration, deceleration and jogging characteristics at stand No. 5.

appear when rolling at speeds above 3600 to 3800 fpm. After some consideration as to the cause of this trouble, the idea was presented that forced load balance might be the possible reason for this condition. It was a simple matter to desensitize this rigid balance by means of a control adjustment so as to allow the top and bottom work rolls to take load more in line with individual demand. This control adjustment was made and the

Figure 7 — Characteristics of stand No. 4 are illustrated as given by the photo-electric recorder chart.



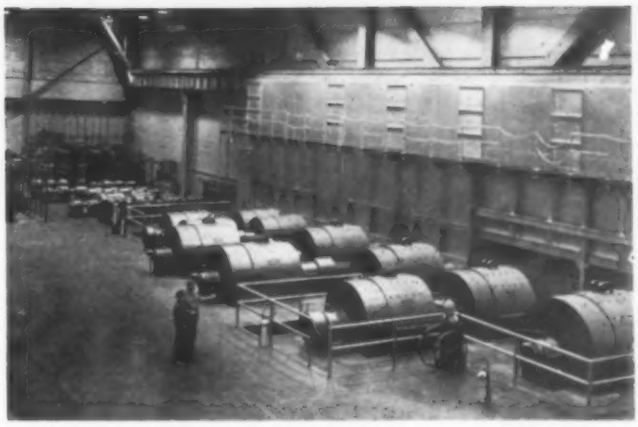
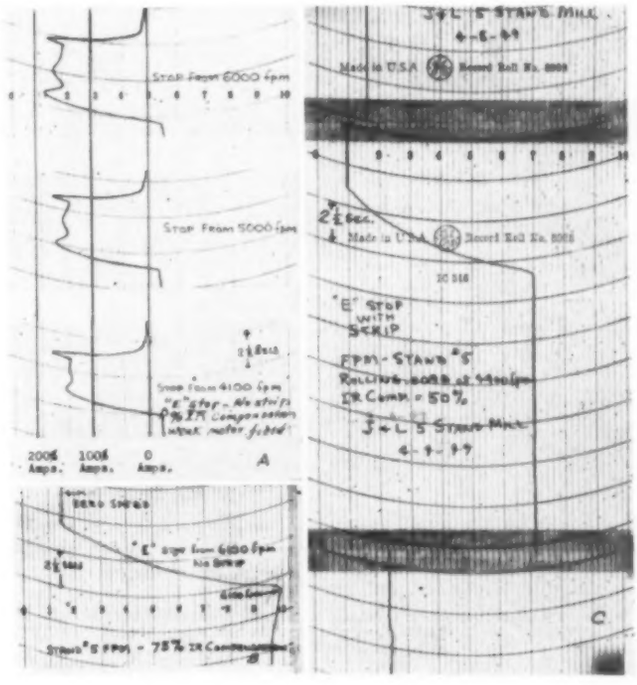


Figure 8 — This 5-stand tandem mill is unique in that it is the first such mill to go into operation with a separate generator for each stand.

mill speed was increased from 3800 to 4500 fpm to check if the scratches were still present. The scratches disappeared and with further increase in speed they did not reappear. As to effect on load division between top and bottom work rolls after the load balance control had been disensitized, it was found that the top roll in general carried less load than the bottom roll; this is due to the fact that better lubrication is usually obtained on the top of the strip. The load division on No. 3 Stand shows more tendency to diverge from balance than Stands No. 4 and No. 5. This division on No. 3 is roughly 45 per cent top and 55 per cent bottom. The net result, after desensitizing the top and bottom work roll load balance control, was an immediate increase in tonnage. The mill operation was improved to such an extent that it broke all its records—a turn of

Figure 9 — "A" shows motor line current on stand No. 5 for "E" stop without strip with 0 per cent IR compensation and weak motor field. "B" shows fpm at stand No. 5 for "E" stop without strip with 75 per cent IR compensation. "C" gives data for "E" stop with strip and 50 per cent IR compensation.



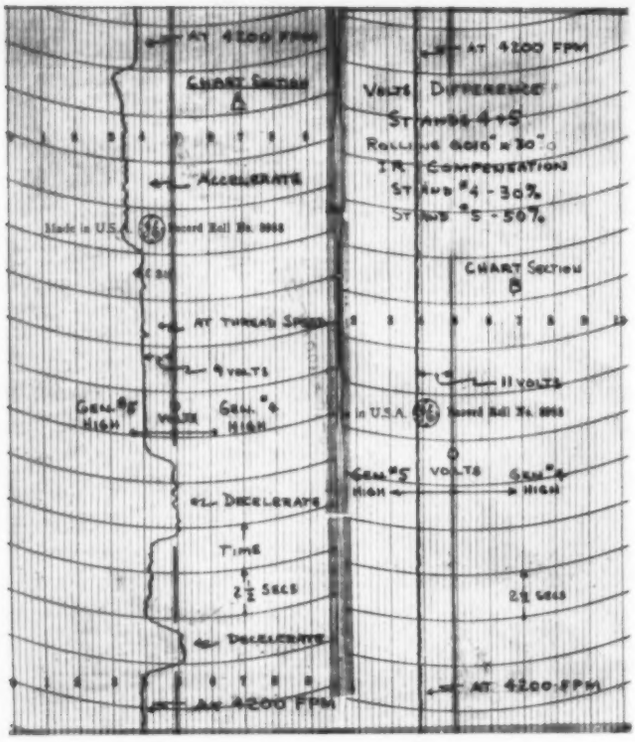


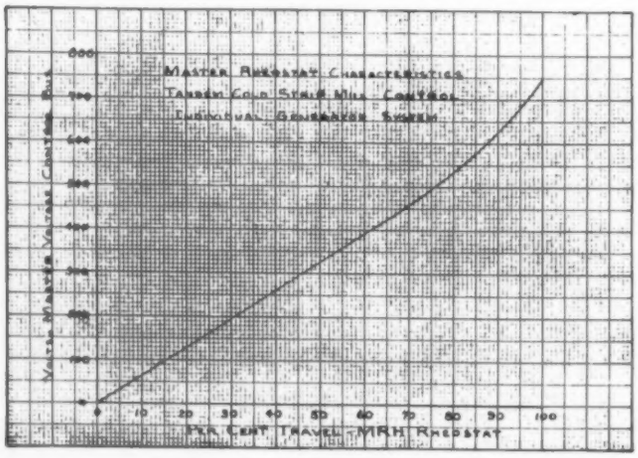
Figure 10 — The stand regulating system controls the difference in generator voltage within very close limits.

over 800 tons was rolled; a few days later 2150 tons were rolled in 24 hours. These records were made on standard tin plate gauges. It might be well to add here that the above tonnages would have been impossible without good welds rolled at top speed.

While some tin plate has been rolled at 6250 fpm, and considerable amounts between 5500 and 5800 fpm, the mill is ordinarily operated hour after hour at speeds between 4000 and 5000 fpm. The average speed is gradually being raised as various problems are solved and difficulties eliminated.

Performance has been checked with an oscillograph and with a photo-electric recorder. Graphic charts reproduced on this paper were all taken on a photo-electric recorder adjusted to be critically damped for a full scale change made in 0.23 second.

Figure 11 — Master rheostat characteristics on control of individual generator system.


MASTER RHEOSTAT CHARACTERISTICS
TANDEM COLD STRIP MILL CONTROL
INDIVIDUAL GENERATOR SYSTEM
VOLTS MASTER VOLTAGE CONTROL BUS
0 10 20 30 40 50 60 70 80 90 100
PER CENT TRAVEL - MRH RHEOSTAT

Present practice is to accelerate from thread speed to 4500 fpm in approximately 9 seconds; a deceleration between the same speeds is made in 7 seconds. Charts showing accelerations and decelerations for front ends and tail ends, and jogging characteristics of Stand No. 5 are shown in Figure 6. Characteristics of Stand No. 4 are shown in Figure 7. The time required between coils from top speed to top speed is seen to be less than 50 seconds.

The travel time of the master rheostat is controlled by the position of the Stand No. 5 coarse rheostat. The rate of acceleration of the mill may thus be maintained approximately constant over a range of rolling speeds between 3150 and 6000 fpm. Winding inertia compensation is automatically adjusted to be correct for operation between any speeds within the operating range. Such refinements are necessary because of the wide range of operating conditions. Schedule requirements may make it necessary to roll at any speed between 2000 and 6000 fpm.

When rolling tin plate at 6000 fpm, approximately 3 tons, or 6000 feet of strip, are being produced every

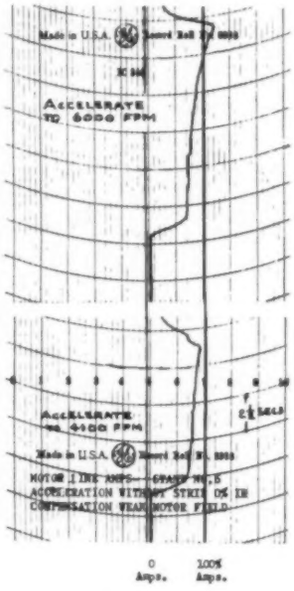


Figure 12 — Chart gives motor line current on stand No. 5 for acceleration without strip with 0 per cent IR compensation and weak motor field.

minute. In the event of an emergency, the quickest possible stop is a necessity. The kinetic energy of the rotating parts of mill and driving motors must be carefully reduced to zero without exceeding the commutating limits of the electric motors and generators. If the stop is made because of a difficulty other than a break in the strip, the strip should not be broken in bringing the mill to rest.

The rotating regulator system used can do all this in approximately 5 seconds. The voltage on the master voltage control bus is dropped, the stand rotating regulators reduce the generator voltages and the motor armature currents are reversed and up to full regenerative braking current in about 1.3 seconds. Stopping characteristics are shown in Figure 9. When stopping from 6000 fpm without strip in Stand No. 5, the regulator tends to hold an average regenerative braking current of 160 per cent rated current and reached 60 per cent of this value in 0.8 second. The last current

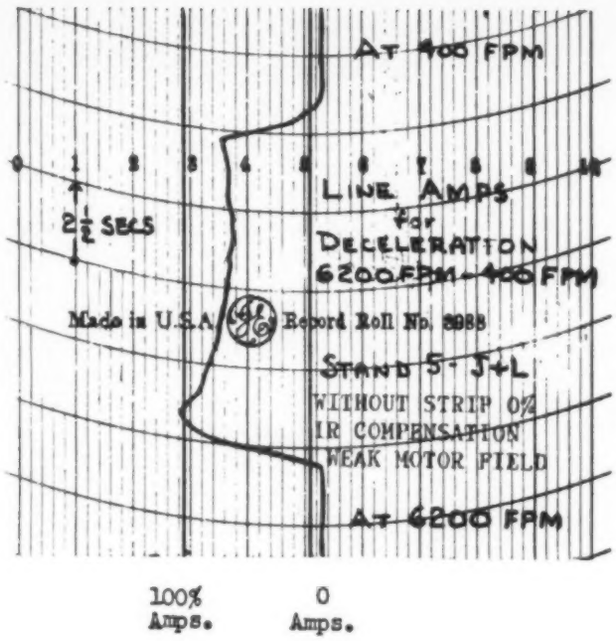
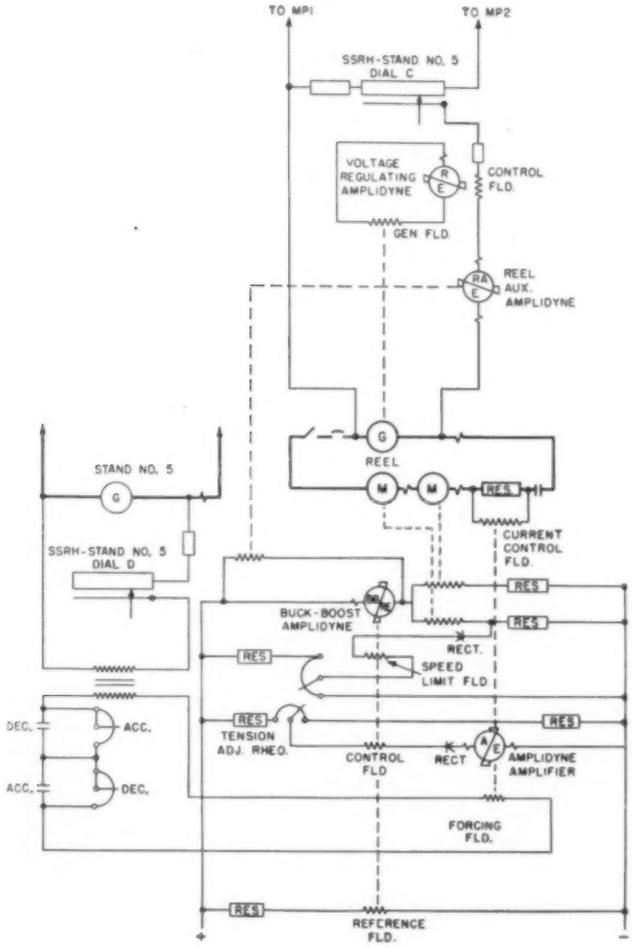


Figure 13 — Chart gives motor line current on stand No. 5 for deceleration without strip with 0 per cent IR compensation and weak motor field.

peak results from a safety relaying system being adjusted to operate before mill actually stops. This relaying system kills reference bus residual voltage and assures the mill coming to complete stop in the event of mechanical failure of master rheostat.

A check of the accuracy of the stand regulating systems is shown in Figure 10. Voltage difference between Stand No. 4 generator and Stand No. 5 generator when rolling 0.010 in. strip at 4200 fpm is shown. Chart section "A" records the accelerating and decelerating currents for Stand No. 5 taken without strip in the mill. Since more IR compensation is used on Stand No. 5 than on Stand No. 4, the generator voltage will be higher on Stand No. 5 than on Stand No. 4. Since Stand No. 5 requires more accelerating current than Stand No. 4, the difference voltage will increase during acceleration and decrease during deceleration. This difference voltage also increases slightly during an acceleration and decreases slightly during a deceleration. This variation follows the change in accelerating and decelerating current resulting from the taper in the master rheostat. This rheostat is arranged to give a larger speed change per inch of travel of the reference arm as the mill speed is raised. Master rheostat characteristics are shown on Figure 11. Chart section "B" of Figure 10 (a) covers about 40 seconds of operation at 4200 fpm while rolling 0.0100 in. strip. During this period the variation in voltage difference between generators 4 and 5 is less than 1 volt. Both generators were operating at approximately 750 volts. Operating conditions were as shown in Table I.

Figure 14 — The rotating regulator control circuit shows tension (current type) regulator and voltage regulator following reference set up by last mill stand.



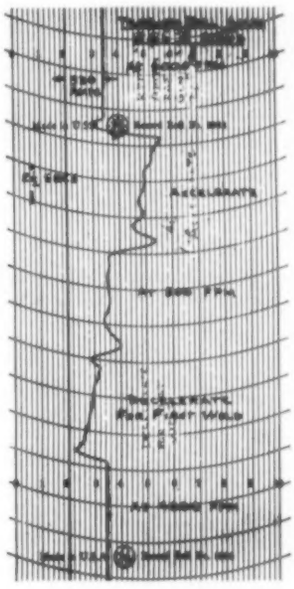


Figure 15 — Chart gives tension reel current for accelerating and decelerating from 4000 fpm.

TABLE I

Voltage Difference Tests — Stands No. 4 and 5
(Rolling 0.010 in. thick strip at 4200 fpm)

	Stand No. 5	Stand No. 4
1. Rated hp	4000	3500
2. Rated amp	4320	3760
3. Load amp	4900	3500
4. Per cent IR compensation	50	30
5. Additional generator volts	19.9	9.5
6. Difference volt	10.4	....

It can be seen that a total variation of 5 per cent in

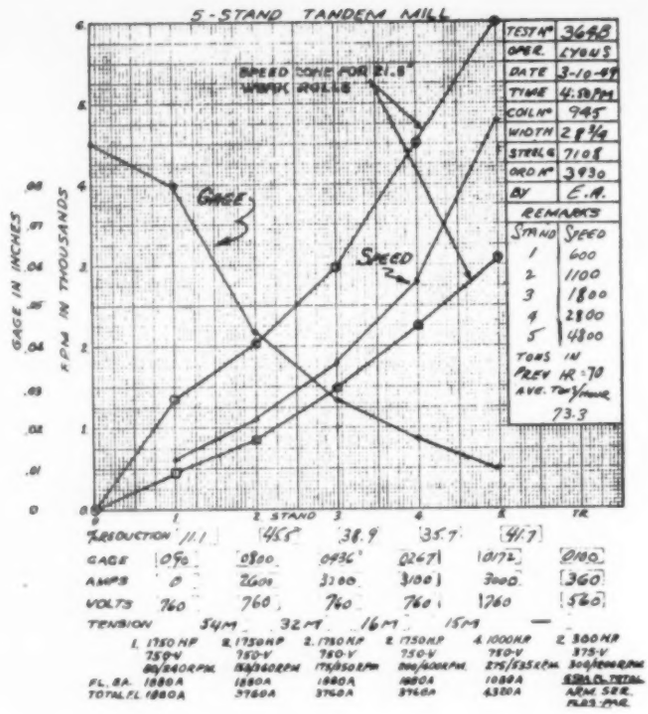


Figure 16 — Typical roll data on the mill is illustrated in this chart.

load on Stand No. 5 could more than account for this variation of 1 volt. Simultaneous variations on both Stands No. 4 and No. 5 of 3 per cent would also account for approximately 1 volt variation.

The control circuit for the tension reel is shown in its simplified form (less stabilizing elements) in Figure 14. The system is arranged so that the reel generator voltage is proportional to strip speed. Dial C on Stand No. 5 speed selecting rheostat provides the proper reference signal for the tension reel voltage regulating system.

Reel building up and automatic tension control are taken care of by a current regulator. This regulator acts to maintain constant reel motor armature current by changing the shunt field excitation on the reel motor. As the coil builds up, the regulating control system automatically increased the shunt field excitation to reduce the angular speed of the motor and to increase the motor torque in proportion to the build up to maintain constant tension in the strip.

Performance characteristics of the current tension regulators are shown in Figure 15. The charts were taken while rolling at 4000 fpm and show the deceleration for the first weld and the acceleration back to 4000 fpm after the weld. The effect of the inertia compensation during the acceleration and deceleration is seen as a change in magnitude of the line current.

Figure 16 might be of interest as it shows an easy method for gathering rolling data on a tandem mill.

DISCUSSION

PRESENTED BY

ROBERT E. NOBLE, Engineer, Mesta Machine Co., Pittsburgh, Pa.

J. R. POWELL, Superintendent, Tin Plate Department, Jones & Laughlin Steel Corp., Aliquippa, Pa.

W. E. MILLER, Steel Mill Division, General Electric Co., Schenectady, N. Y.

C. J. KLEIN, Chief Engineer, Weirton Steel Co., Weirton, W. Va.

GEORGE A. KAUFMAN, Chief Electrical Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

G. E. STOLTZ, Consulting Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

JULIUS E. GRAF, Chief Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

R. E. Noble: You must all be impressed with the variety of auxiliary equipment necessary to run a mill of this character, and the difficulty that is involved in learning to run it. The mill has been in operation for two years, and you can imagine that in starting it, there was considerable difficulty in learning to operate it.

These papers have been written from the operating viewpoint, and I have been extremely interested in listening to a summary of the things that were experienced during the initial stages in the operation of the mill.

One feature of the mill, of course, that is most interesting is that the last three stands are driven by motors that drive the working rolls individually. No provision was made for tying the rolls together mechanically. Each roll was driven individually and at the time the mill was designed the speeds were certainly unprecedented and a great step ahead of current practice. The fact that it worked out so well is a tribute to the men who worked out the control system of the mill.

Mr. Powell has emphasized the importance of strip lubrication and other features in operating the mill. There is one question I would like to ask him: What his present practice is in the matching of work rolls?

J. R. Powell: We grind our rolls closely to diameters, but we have actually taken rolls with a quarter inch difference in diameters and operated the mill successfully for long periods of time, as an experiment.

George A. Kaufman: I might add that with a difference of a quarter inch in the work roll diameter, you could hardly find the difference between top and bottom roll load. You will find much more difference in work roll load due to different distribution of palm oil top to bottom of strip.

R. E. Noble: There is one feature in the design of the mill that may not have been mentioned or brought out in the discussion. There is usually a difference between motor speed and roll speed, and now, with this mill, instead of slowing down the roll speed compared to the motor speed, as is usually the case, the roll speed is increased as much as two to one, on Stands 3 to 5 inclusive. That is of course a matter of necessity due to

limitations of motor design and of course it is a matter of necessity that those gears were put in there.

We used to think, if we could be fortunate enough to get a motor which ran at the right speed for the mill, we would be rid of our gear trouble, but at these high speeds, we still have the gears, only in reserve speeding up the rolls instead of slowing them down from the motor speeds.

We notice the extreme smoothness of acceleration, and that in spite of the fact of great mechanical inertia, it is possible to get smooth acceleration to the top speed of the mill in around nine seconds and deceleration in seven seconds, without overshooting as the curves showed. The control is excellent in that respect.

W. E. Miller: The curves that Mr. Kaufman showed indicate, as Mr. Noble said, that there was no overshooting. You can rest assured that that was not an accident. It was decided way back when the control equipment was first being designed, that such performance would be necessary to insure good rolling performance at top speed and at thread speed.

Almost everyone has seen frequency response curves for radio amplifiers and receivers. A tandem cold strip mill has a frequency response curve too. It is possible to calculate the frequency response curves for such control systems, and also make tests, either in the field or in the factory, to verify the results. Once you know how one system performs under actual operating conditions, such as during acceleration and deceleration, and when you have the system's frequency response curve, you can very accurately predict the performance of similar systems by comparing their frequency response curves.

This five-stand tandem mill was the first tandem cold strip mill to go in service using the rotating regulator controlled individual generator system. However, it was not the first such controlled individual generator system to be set up and tested for a tandem mill. We had a factory setup, with our testing department's 2,000-hp motor, large motor-generator set, rotating regulators, exciters, stabilizing transformers and capacitors. This test motor was accelerated, decelerated, jogged and stopped, under all possible conditions, and with varying amounts of IR drop compensation as expected in actual operation.

The frequency response curve of the "sample" control system was obtained by test and by calculation. The frequency response curves were then calculated for the Jones and Laughlin tandem mill system, as well as for several others—it was not necessary to make any additional factory tests. The circuit constants in the equipments being built were adjusted to obtain the desired frequency response characteristics, and expected performance was obtained in the field. It is our belief that everyone gained as a result of these factory tests. Certainly J & L and others gained by achieving high production in a relatively short time.

Neither Mr. Kaufman nor Mr. Powell have commented on one other characteristic of the mill system which the operators feel is most valuable. This is the rapid response of the system in establishing back tension when a stand is threaded. It is a most valuable characteristic, in that it limits any camber to an insignificant length of strip and makes it easy to thread the remaining stands. I believe it would be interesting to see some oscillograms taken on buildup of tension as a function, maybe, of IR compensation when sticking a stand.

C. J. Klein: I was interested in knowing just what tensions they were able to hold during acceleration and deceleration of the mill, from threading speed up to high speeds? And if these tensions were being held very closely, what effect it would have on the final gage in the product delivered to the reel?

George A. Kaufman: These tensions during acceleration and deceleration are very easily controlled by adjusting the IR drop compensation percentage, and the operators can very readily take care of that by instant adjustment on the mill control cabinets. For instance, on the softer grades of steel they usually use a higher percentage compensation than on the harder grades. You will find that tensions will hold constant during the accelerating period if these adjustments are made correctly.

C. J. Klein: There is one other question I had, and that is on the 1300 viscosity oil, I was wondering whether one lubricating system for the backup roll bearings is satisfactory?

J. R. Powell: At the present operating speeds and the present viscosities, we see no need for splitting. We are prepared to do it, our tanks are split to do that, and we may on the lower speed stands, if we go down to a lower viscosity, have to split the two systems. However, at the present time we have seen no indication at our present viscosities, of that need.

C. J. Klein: We have one other problem, which may or may not be prevalent in the operation of the Jones and Laughlin mill, and that is, if the mill for any reason is stopped with the strip in the mill, is it necessary to immediately release the screwdown to start it up again? Or is the mill able to set in a loaded position for a period of time?

George A. Kaufman: No. This mill has 75-hp screwdowns, with a high speed gear ratio. If we are rolling quadruple coils and wish to cut and strip the reel on half of the coil, rethread the reel and start up again, we find it necessary to release the pressure on stands No. 4 and 5 if you allow them to stand for 25 to 60 seconds depending on rolling schedules. We have found this screwdown to be quite rapid in speed and response so that we can release the roll pressure, rethread the reel, and reestablish roll pressure in a hurry and accelerate.

C. J. Klein: In the exhausting of the vapors and fumes from the mill with this underground duct, I was wondering whether you had made any provision for eliminators in getting rid of the palm oil and the water vapors, or whether you exhaust all of that material to the open?

J. R. Powell: The downdraft fans throw into a tunnel and it is exhausted directly into the air outside. We have seen no indication of any palm oil fumes or anything of that nature to bother anything. Of course, our mill runs very cool, we think it is cool compared to other mills. In investigating the tunnel, it is surpris- the small amount of palm oil or lead or dirt or anything else that sticks to the sides of the tunnels.

C. J. Klein: Mr. Powell could you state what percentage of palm oil you are reclaiming from the mill, also how much palm oil per ton of steel are you using?

J. R. Powell: To answer your second question first, we are averaging about four pounds per ton. That is not good enough. Our management—and we agree—think it should be lower. We have gone for a period of a month or more at three or three and a half pounds per ton. That of course does not include the palm oil put on the pickler.

On your first question, we do not reclaim our oil as such. We have reskinning tanks, in which we let the oil come to the surface and skin it off, and that is palm oil with quite a lot of water. It is not a type that you would want to reuse in the mill or sell. Palm oil has ceased to be a rare commodity, as you know, and where we were formerly able to sell it for a good price to different buyers, at the present time we are using it for fuel oil.

C. J. Klein: I might say, at Weirton we started out with a system such as Mr. Powell described, and during the process of elimination we finally got away from the mixing of the oil with water, and at the present time we are placing it on the strip with sprays. Due to that result, of course, there is more palm oil floating around in the air than there would be if it were put on as a combination. However, our operators tell me that that is a better way of getting it on the strip uniformly.

There is one other point that is interesting to me, and that would be if Mr. Powell would know the total amount of water per ton of steel that he is using in cooling, that would be put on the mill and wasted to the sewer?

J. R. Powell: We use in the neighborhood of 3500-4000 gpm.

G. E. Stoltz: In rolling tinplate at the speed they are using, it is not surprising that they have experienced operating conditions that do not prevail at lower speeds. Mr. Kaufman has indicated that they have experienced slippage under certain circumstances. We believe the coefficient of friction between the strip and the rolls decreases with increased speed. This no doubt accounts for the fact that slippage has become a factor that has required their attention.

We are in agreement with Mr. Kaufman in regard to desensitizing load balance control between the motors driving the top and bottom rolls of a given stand. If there is a tendency for either the top or bottom roll to slip, the motor driving the roll that is slipping will tend to take less load than the motor driving the roll that is not slipping. Load balance control would simply increase the speed of the motor driving the roll that is slipping that much more.

I would like to have Mr. Kaufman's opinion as to the desirability of controlling the twin motors in a manner which would tend to have them operate the rolls at the same speed and allow them to take such load as would be imposed upon them. This would not only avoid having the control contributing to slippage, but would tend to avoid it.

Another interesting point discussed by Mr. Kaufman is that by the use of twin motor drives it is possible to compare the application of palm oil on the top of the strip with that on the underside of the strip. Where pinion drive is used there is no possibility of comparing the amount of power delivered to the two rolls.

George A. Kaufman: With the load balance control on these twin drives, we have a differential instrument that shows the side on which the load is tending to diverge. For example, if the top roll seems to take less than the bottom, and of course that means the bottom takes more, the roller attempts to apply a little more oil on the one that is taking the most load, and when he does that, you find the load tends to come more in balance.

As to your question, why do we need any load balance at all, I really think we should have some semblance of balance in order to not have too sloppy a control, not one that would dictate too much as to the division of load, but enough there to keep the motors more or less pulling their traces.

G. E. Stoltz: My reason for asking this question is that I feel it is very important to know how best to apply palm oil to avoid slippage on high speed mills. It is interesting to note that you are using twin motors to give you an indication of the application of palm oil on the top and underside of the strip.

Julius E. Graf: We are proud of the mill that we have at Aliquippa. It is not a package mill, either from the standpoint of the mill, the electrical equipment, or anything else in it; it is not one that was bought off the shelf. And without detracting from the good work that was done by the manufacturers of the equipment that went into that mill, I want to say that we had the finest cooperation from them in meeting us and making changes that our engineers and our operators suggested as the plans were developed on the board. It is a combination of engineering from all standpoints. We considered everything. We considered not only the speed, we considered the safety, and we considered what was available from the standard shelves.

We feel that we have an operation that we can be proud of.

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SUPERVISORY CONTROL AND TELEMETERING

as Cost Reduction Tools

. . . . any equipment which can give an electrical or mechanical indication of its status can be controlled at a remote station . . . . such methods enable one supervisor to efficiently coordinate production and also result in reductions in operating costs . . . .

By E. WYLIE HEAD
Sales Manager
Control Corp.
Minneapolis, Minn.

▲ THIS paper will explain supervisory control and telemetering, what they can do, how they work and some of the factors to be considered in their application. Before the war supervisory control and telemetering were primarily of interest to a minor number of electric utility engineers. Today most electric utilities have active systems of supervisory control and telemetering in service or are laying plans to adopt these in their operations. In addition to this, engineers in an increasingly larger number of industries are also starting to turn to supervisory control and telemetering as cost reduction tools. It is the author's belief that the steel industry will also find these subjects of economic interest.

Whenever any industry starts spending its money for new methods or new equipment, there is always the very compelling reason of more economical operation. Such is the case with supervisory control and telemetering. Two economical advantages result from the use of this type of equipment. The first of these is the economic advantage of lower operating cost. The second offers a less tangible but equally important factor of improved operating efficiency. Operating costs can always be reduced when machinery or equipment can be used to replace manpower. On this basis supervisory control and telemetering can easily be shown to offer operating economies of substantial magnitude when compared with the cost of the equipment. Such equipment will allow one operator at a central point to control, supervise and meter equipment and processes at one or more remote points. The savings that result in this case are in the form of wages of operators that would normally be used to man the remote points. The savings of wages of operators over a period of one to two years will usually buy enough supervisory control and telemetering equipment to allow these operators to be eliminated.

On the intangible, but nevertheless important, side of the ledger we find savings due to increased operating efficiency, better overall supervision of related equipment or related processes, ability to gather vital information quickly in times of emergencies and the ability to quickly affect control of remote equipment during such emergencies.

This equipment will allow one central operator to control and supervise remotely located but related equipment. He has information before him at all times in the form of lamps and meters to give him as complete a picture as is necessary of the functioning of this remote equipment. If any change takes place in this remote equipment he has this information immediately in front of him and can evaluate this change in relation to the other equipment under his supervision. In addition he has the ability to control any of this remote equipment at any time that he feels is necessary to maintain maximum operating efficiency.

Under this plan one man has the complete picture of all equipment and the ability to affect controls. One man with complete knowledge and with complete control facilities can do a much better job of efficiently operating integrated equipment than can a group of men at remote points who have only an incomplete picture of the overall system.

Since most supervisory control and telemetering equipment have so far been used primarily for the control of electrical equipment, the logical first choice for application of this equipment in iron and steel operations would be in the control of electrical equipment. The use of supervisory control to allow one operator to control and supervise the circuit breakers in the electrical distribution system will not only reduce operating expenses, but will improve operating efficiency for the entire plant. The use of telemetering to bring in load consumption information from various points in the electrical system will allow more efficient use of plant generated power and hold down peak demand charges for purchased power.

Supervisory control of circuit breakers in the electrical system can reduce operating costs by first allowing the elimination of operators at the various switching centers or substations. As was mentioned earlier, this factor alone can probably justify the use of supervisory control. By placing control and supervision of these substations under the direct control of one man he will be informed almost instantly of the power outages or circuit breaker operations that might jeopardize operation of the plant. By giving one man complete information concerning the functioning of the electrical system of the plant he is in a position to quickly take intelligent steps to correct this situation and can thus materially reduce shutdown expenses due to power outages. He also has the ability to perform switching operations that can by-pass the circuit in trouble or bring in alternate sources of power as required. These can add up to lower shutdown time and lower shutdown expenses.

The addition of telemetering to this picture will enable this central operator to watch electric power consumption for not only the entire plant but individual electrical loads. As loads increase beyond desirable values in terms of either plant generating capacity or demand charge limitations, the operator can cut out less essential loads and prevent overloading of plant generation capacity and reduce demand charges on purchased power.

Recently many gas companies have either installed supervisory control for the control and supervision of gas valves and pressure regulators or are contemplating the installation of such equipment. For this reason it would also appear desirable to consider the application of supervisory control and telemetering to the gas system of iron and steel mills. Such equipment would enable a central operator to know the position of remote valves, the pressure in various gas lines, the amount of gas in gas holders, the setting of pressure regulators, the consumption of gas by various units and the amount of gas being delivered to outside users. This same central operator could have complete control of valves and pressure regulators.

Direct savings that would result would be in the elimination of either permanently located or traveling operators for manipulation of valves and regulators as well as for the reading of gas values in gas holders, consumption and other flow information. Intangible values would also result in the form of better control and use of the gas that was being used or sold.

Another use that suggests itself is the telemetering of information concerning water storage in tanks, water use in various departments, as well as total use by the plant, water pressure and possibly the position of controlling valves. Coupled with this would be the control of valves and pumps connected with the water system of an iron or steel plant.

The same savings outlined above for electric and gas systems would also be evident by the use of this type of equipment for control, supervision and metering of water values.

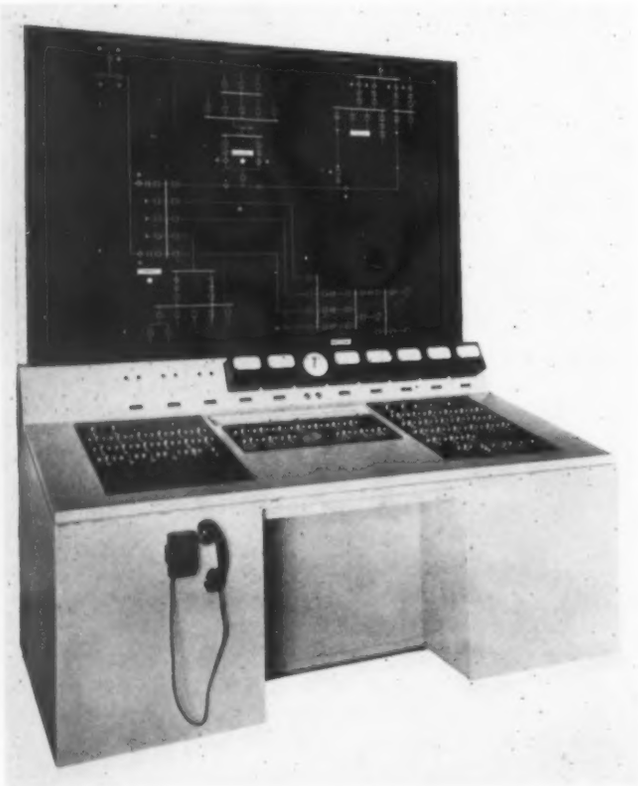
The use of supervisory control, together with an illuminated electrical plant diagram, should be of material assistance to the plant manager or other person directly concerned with the overall operation of the plant. The map would consist of a schematic or one-line diagram of the equipment involved in the iron or steel plant. Symbols and their appropriate relation to each other will denote the various types and classes of equipment. Lamps behind each of these symbols would cause the translucent symbol to assume a color characteristic of the status of the equipment at that particular time. The lamps themselves could be controlled either by direct wire between the map and the equipment involved or by supervisory equipment that would allow a large number of lamp signals to be transmitted over a single pair of wires. Alarms could be sounded whenever an important change took place in any of the plant units involved.

Such a map would give the manager a complete overall picture of the status of all equipment under his supervision. Such a map allows the status of the entire plant to be quickly appraised and points out the shutdown of any important equipment as well as its relationship to other equipment in the plant. Figure 1 illustrates the use of such a map by an electric utility and Figure 2 shows the use of the map by a pipe line company for supervision of a tank farm.

An example of the equipment used for the supervisory control of electrical equipment associated with steel mills is shown in Figure 3. Figure 3 shows the equipment as used by a Canadian metallurgical company for the control and supervision of furnace circuit breakers.

The use of supervisory control and telemetering for control and supervision of electric, gas and water facilities are standard applications of such equipment. Other applications will call themselves to your attention as you become more familiar with operation of this equip-

Figure 1 — The illustration shows an electric map and supervisory control as used by an electric utility.



ment and the factors in its application.

Although the subject of supervisory control and telemetering has become of interest to a large number of engineers only recently, the subject has been of interest to a smaller number of engineers for a comparatively long time. Because of this interest over the years various schemes for remote control, remote supervision and remote metering have been developed.

One of the first systems for remote control and supervision involved the use of multi-conductor circuits and was of the direct wire type. In this instance, sufficient circuits were provided to allow a circuit for each operation to be remotely controlled and for each function to be remotely supervised or metered. The main advantage of direct wire control is simplicity and lower cost in some cases over short distances.

As the number of circuits involved become greater or the length of the circuits become greater, the cost of providing circuits for this type of control becomes prohibitive. For this reason consideration was given to systems that would allow a comparatively large number of operations to be carried on over a relatively small number of circuits.

Probably the first systems to allow supervisory control over a small number of circuits were based on principles somewhat similar to that used in modern dial telephones. In such systems a dial served as a pulsing device to transmit a variable number of pulses to the remote location. At the remote location these pulses were counted and the number of pulses received determine what function would be operated. As this system improved the dial itself was eliminated and the character of the pulses was determined by the operator's selection of buttons or keys on his control panel. This system of control is still used on some systems of present day supervisory control with the number of pulses or the timing between pulses being varied to provide the selecting signal.

The designer of supervisory control equipment is constantly faced with the problem of providing equipment that will be absolutely reliable. We can easily understand that supervisory control equipment that is not reliable is worse than useless because of the ever present danger that equipment will be operated that is not intended to be so operated. In addition to designing terminal equipment so that it will do the job it is intended to do, he must also design his equipment so that line conditions cannot distort his signal to cause false operations. Such line conditions include intermittant open or short circuits that may modify the characteristics of a signal, induced signals that may simulate control signals and voltage build-ups that may also cause difficulties. Although such line conditions may be rare, they must nevertheless be provided for in the design of the equipment as such equipment is usually used over a long period of time.

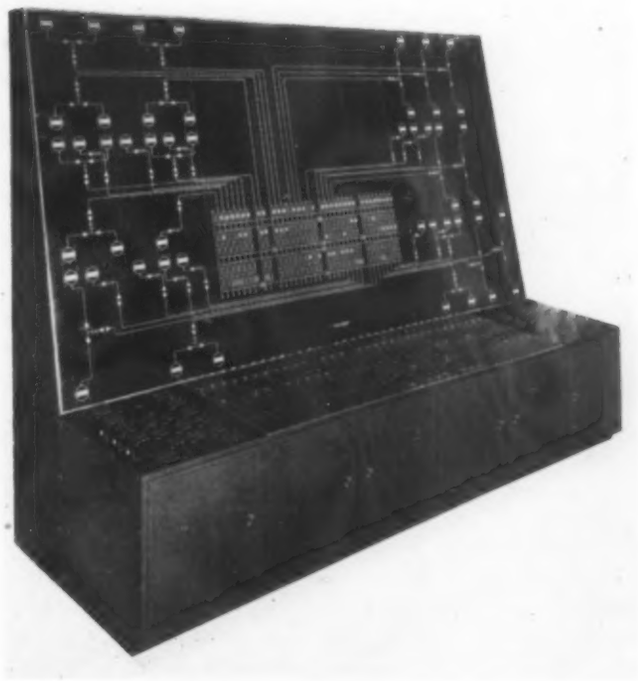
Intermittent open or short circuits can drop out a signal component, or split a signal component so that two signal components will appear at the remote end where it was only intended that one should appear. Induced voltages on the remote line can either modify the characteristics of the signal or even simulate a complete signal. Excessive voltage build-ups on the line cannot only endanger the equipment and associated personnel, but can also be a factor towards unreliable operation.

Because of these possible line conditions we find that the impulse system of supervisory control is always open to the possibility of false or improper operation of remote equipment. To overcome this possible unreliability, designers using impulse systems have provided a form of verification signal that is sent back from the remote station and verified. If the signal being received from the remote station corresponds to the signal sent out from the controlling station, then the equipment will allow an operating signal to be transmitted. In an attempt to secure reliability, this operating signal is also usually coded to reduce the possibility of line characteristics modifying the characteristics of the control signal.

Although supervisory control designers using the impulse system express complete confidence in this system from the standpoint of reliability, other design engineers contend that this system is open to additional technical criticism. This latter group contends that the impulse system depends upon marginal factors for its interpretation of the control and supervisory signals. It is felt that aging of components, vibration and similar factors may change the response characteristics and cause operational troubles or operational errors on any system that depends upon a variation in the number, timing or intensity of signal components.

In order to overcome the limitations of the impulse system of supervisory control, another system has been devised that is radically different in the signals used for remote control and remote supervision. On any given installation with this system, the number of signal components is fixed. These signal components are in the form of audio frequency tones and the intelligence that each signal contains is dependent only

Figure 2 — Electric map and control panel used by a pipeline company.



upon the sequence or order in which the tones are transmitted.

Such a system has one advantage in that a comparatively small number of signal variables can be grouped together to provide a relatively large number of signal combinations. For example, a three part signal using three different audio tones can provide for the closing and tripping of twelve circuit breakers. A four part signal using four different audio frequency tones can provide for the closing and tripping of fifty-four circuit breakers, while if a five part signal is used with five different audio frequencies, this system can be provided for the control of 160 circuit breakers. The number of useable combinations is cut down somewhat due to the fact that all combinations having the same tone following itself are rejected. Possible difficulties due to the splitting of signal components are eliminated by designing the equipment so that the receiving equipment will reject any signal in which one tone immediately follows itself. Possible difficulties due to the loss of the signal component because of line conditions are eliminated because the design of the equipment is such that all signal components have to be received before any operation takes place.

It is recognized that one or more of the audio tones used as signal components may be induced upon the control line. Because all signal components have to be received at the remote station before any operation takes place, the appearance of one or two of these audio tones due to induction would not cause any operation at all. In order for remote equipment to be operated, each audio tone in a signal group must be transmitted in accordance with a definite and restrictive sequence. In addition there must be a definite break between signal components in order for an operation to take place.

Upon the basis of both theory and extensive operating experience designers of this "sequence" type of remote control equipment feel that it can be depended upon to select and operate remote equipment without the use of a verification signal. Designers of this type of equipment wait until the equipment is actually operated and then transmit a signal back to give instantaneous proof of operation.

Other differences between the two systems of supervisory control will also appear upon examination, including the means used to allow an operator to check the position of remote equipment and in the means of reporting automatic changes in remote equipment.

In addition to basic differences in circuits used, the two groups of design engineers also differ in their approach to the problem of mechanical construction. The first group normally uses permanently wired relays on fixed panels, while the second group mounts their relays upon swinging panels for greater convenience and uses plug-in relays.

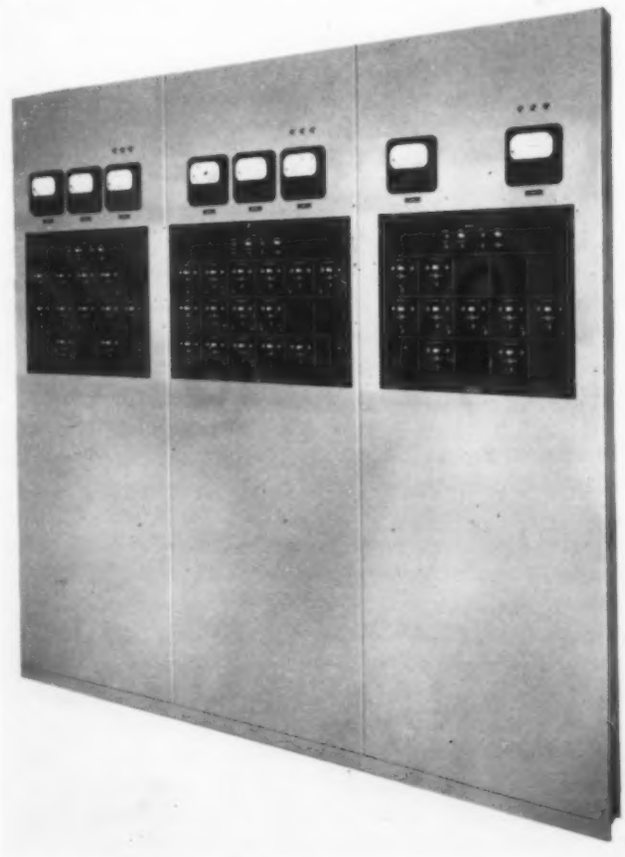
Other differences in design thought appear when we investigate the number of functions that different design engineers will allow to be used upon the remote control circuit. Some equipment limits the use of remote control circuit to supervisory control only. Other equipment will allow not only the circuit to be used for supervisory control, but will also allow its use for telemetering and voice communication. Since these factors have a direct bearing upon installation expense as well as fixed charges during the life of the equipment, they should be fully investigated at the time such equipment is contemplated.

As is the case with supervisory control there are also a number of systems of telemetering available. Telemetering systems can be classified in a variety of ways, depending upon the factors involved in a given problem.

One method of classifying telemetering systems would depend upon the amount of power or torque available to position the telemeter element. If we were to telemeter roller position in a rolling mill, we would have a comparatively large amount of power or torque to position the telemeter element. When we proceed to the telemetering of voltage we find that we very seldom can extract any appreciable amount of power from the voltage circuit or element without seriously affecting the accuracy of our telemeter reading. Most telemetering problems are in the latter class and the various designs available represent different approaches to the problem of translating the value to be measured into a telemeter signal.

Some telemetering systems use a continuous signal and vary some quality of this signal as the intelligence part of the signal. Other systems transmit a periodic signal with the duration of this signal being a function of the value being measured. Some telemetering signals require a direct metallic path for the transmission, while others are suitable for transmission through insulating transformers, over a carrier current channel

Figure 3 — This equipment is used by a Canadian metallurgical company for control of furnace breakers.



or even over a radio channel. The type of channel available for transmission of telemetering signals may frequently determine the design characteristics of the telemetering equipment. Anyone considering the application of supervisory control or telemetering would be wise to call in a specialist in these fields. The problems associated with the application of this type of equipment are peculiar to this type of field. If both supervisory control and telemetering are involved it would be wise to consult representatives of companies in a position to supply both types of equipment so that these two types of equipment can be coordinated to comprise a satisfactory installation.

It is quite probable that your particular problem may be different from any that has been met by the engineering representatives you call in, however it is also undoubtedly true that such representatives have encountered most or all of the elements of your particular problem at some time or another.

Certain information will be required before any recommendations can be made concerning the proper equipment for your application. This information will of course include the number of functions that are to be controlled, the number of functions that are to be supervised and any telemetering functions that are involved. In some cases the number of control and supervision functions will be identical, although in general, there will also be alarm conditions that are to be supervised in addition to supervision of controlled equipment.

Information concerning the type of remote control circuit or channel that will be available will also be necessary. In addition to this, the number of remote locations to be controlled or supervised over a common channel should also be known. Although most supervisory control applications involve the use of a separate circuit to each remote location, this is by no means necessary. It is quite easy to provide equipment in which several remote locations can be controlled and supervised over a common channel.

In general, one pair of wires or one channel is all that is necessary for supervisory control and telemetering. Because of the high cost of control circuits, most modern supervisory control equipment has been designed to allow a relatively large number of control and telemetering functions to be carried on over one pair of wires. Circuit length and characteristics will have a bearing upon the design of supervisory control and telemetering equipment, however, and such information should be available when applications of this type of equipment are considered.

Modern supervisory control equipment can be obtained for operation from any common power supply and this does not as a rule have any bearing upon the cost of this equipment. Information concerning power supplies available should be given to anyone called in and asked to furnish recommendations. This equipment is quite often operated from station batteries because such batteries furnish a more reliable type of power supply than a-c power. However, there are cases that lend themselves to operation from an a-c power supply. In some cases, equipment is designed to normally operate from one power supply with automatic switch-over to an alternate power supply if the first one fails.

Space available for location of equipment sometimes enters into the design of supervisory control and telemetering equipment. In other cases customers have preferences that dictate the choice between cabinets, panels, cubicles, desks and other forms of housing for such equipment. Most manufacturers are in a position to offer you the type of housing that best meets your overall requirements.

When telemetering is required along with supervisory control, several additional factors come into the picture to be considered. The first problem to be considered when telemetering is involved with supervisory control pertains to the number of telemetering readings that are required to be continuously delivered. Where continuous telemeter readings are required, these can usually be transmitted over the same circuit used for supervisory control. Since continuous telemetering is usually more expensive than selective telemetering, it is wise to consider the possible use of selective telemetering in place of continuous telemetering. Selective telemetering, in which one reading is called for at a time at the discretion of the operator, can quite often provide adequate information concerning remote meter values.

With either continuous or selective telemetering, an application specialist can usually show how it will be possible to reduce costs substantially by causing telemetering equipment to do double duty. An example of this might be in the telemetering of kilowatts and kilovars in which one telemetering transmitter could be used for the telemetering of both of these values. Where selective telemetering is used, one transmitter and receiver can frequently be used for the telemetering of several different common values in turn.

If outdoor weather-proof housing is required for any of the equipment, this should be made known to the application engineer as well as any information concerning corrosive conditions, unusual dust conditions or other conditions that might result in operational difficulties if not protected against.

In closing I would like to again point out that supervisory control and telemetering are cost reduction tools. Supervisory control can be used to control any remote equipment that is subject to control by closing an electrical contact. Any remote equipment can be supervised that can give an electrical or mechanical indication of its status. Almost any value can be telemetered that can be made to give an electrical or mechanical indication of itself. While supervisory control and telemetering do not constitute a cure-all for all high cost operations, they do have a definite place in the field of cost reduction and their use should be generally considered over the entire plant operation for possible savings.

In addition to direct savings that result from the use of supervisory control and telemetering, other intangible savings will result that cannot be directly evaluated but contribute to overall lower operating cost.

DISCUSSION

PRESENTED BY

W. A. DERR, Switchboard Engineering Department, Westinghouse Electric Corp., Pittsburgh, Pa.

E. WYLIE HEAD, Sales Manager, Control Corp., Minneapolis, Minn.

W. A. Derr: Supervisory control is not as new to the steel industry as seems to be indicated by Mr. Head's paper. Supervisory control for six substations was installed in the Gary works of the Carnegie-Illinois Steel Corp. in 1942[1]*. Since that time there have been installations of supervisory control made by quite a number of other steel companies, the most notable installation being that made in the Geneva Steel Corp. plant[2] in Provo, Utah in 1943. This installation involved the control of eleven substations from a single central dispatching point with a total of more than 500 functions being performed. Several of the companies have made extensive additional installations since first applying supervisory control.

The type of equipment applied for the installations cited is of the all-relay coded impulse type. All codes consist of a series of impulses with all impulses being of the same length. No critical timing is involved, the selection being determined by the number of impulses transmitted. A check-back is employed to assure that proper selection is made.

Despite Mr. Head's inferences to the contrary, there is no more positive method of picking out one of a group of devices and providing definite indication that the desired device is selected than by use of a verification signal individual to each device. Any system of signalling may be subject to external interferring or disturbing voltages which can result in an incorrect selection. If selection must be verified before operation is possible, an incorrect selection cannot result in incorrect operations or indications. Mr. Head states that the multiple audio frequency system waits until the device is operated and then provides "proof" of operation. "Proof" of operation of a device is hardly adequate information when there is any possibility that it can be other than the desired device. For the type of devices for which supervisory control is usually applied, accuracy of operation and indication is of prime importance. The elimination of any feature which inherently detracts from accuracy is not justified. Supervisory control has continued to gain greater acceptance in the industrial, central station and railway fields since its inception in 1921, primarily due to the reputation for reliability established by impulse systems employing a check-back. The necessity for the greatest possible accuracy was recognized by the men who pioneered the development and application of supervisory control systems. I would like to briefly quote from a letter written July 29, 1949 by R. J. Wensley who was the principal figure in the development of the first supervisory control system which was furnished the Cleveland Railway Co. in 1921.

"Our first requirement was accuracy and dependability. We proceeded on the basis that the supervisory control must not make mistakes. If the selective equipment of the dial telephone fails, an apology settles the matter, but a wrong oil circuit breaker operation can be very serious. The Cleveland equipment employed an automanual check-back which insured that the dispatcher could verify his selection before the actual operation was completed. Some form of check-back, either partially manual or wholly automatic, has been incorporated in all equipments manufactured by us since that time."

Reliability is second in importance only to accuracy in a supervisory control system. The coded impulse system is made up entirely of standard telephone type relays. The reliability of these relays is demonstrated by the fact that the original Cleveland Railway installation is still in daily operation. No expendable parts are employed and a minimum of maintenance is required.

The reliability of a supervisory control system is closely related to its signal requirements. The early supervisory control systems employed more than one signal receiving element at each station. It was soon recognized that the signal receiving elements are the most vulnerable part of a system since they are subject to the changes and disturbing voltage conditions to which the interconnecting channel is susceptible. Modern coded impulse systems require only a single signal receiving element at each station. For operation over a pair of telephone line wires this single receiving element is a d-c relay. Only a single receiving element is required regardless of the number or types of functions performed. This is in contrast to the multiple audio frequency system which requires a number of tuned receiving elements at each station, with the number of such elements being governed by the number of functions performed.

The use of d-c signalling over telephone line wire is preferred over audio frequency signalling for the following reasons:

1. Audio frequency signalling results in greater susceptibility to interference from electrical disturbances as well as from other services in adjacent or nearby telephone line wires.
2. Audio frequency signalling is more likely to interfere with services in adjacent or nearby telephone line wires.
3. Audio frequency signalling necessitates the use of expendable parts such as tubes.
4. For operation over long distances of cable wires, repeaters may be necessary with audio frequency signalling. D-c signalling has been employed over cable wire lengths in excess of one hundred miles.

The relays of coded impulse equipment are grouped in metal cases which are suitable for switchboard mounting. Thus, the relay equipment is suitable for any desired type of construction. The control keys and lamps for each device are mounted on a small molded

*Numbers refer to bibliography at end of this discussion.

plate called an escutcheon. These escutcheons can be grouped in any desired arrangement. When circuit breaker control is involved they are often located in a mimic bus arrangement.

Modern coded impulse type supervisory control can provide for any types of functions which can be provided by any supervisory control system. Since this system has minimum signalling requirements, it can often be applied where no other system could be applied. For example, it is the only system which can successfully control a large number of stations on a single frequency power-line carrier channel. This system was the first to be successfully operated on power-line carrier and microwave radio channels.

In conclusion, I would like to point out that our experimenting with audio frequencies for supervisory control signalling on telephone line wires more than twenty years ago proved that the choice of d-c impulse signalling by the Bell Telephone Co. was made with reason. It is to be noted that the Bell Telephone Co. still employs d-c impulse signalling.

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E. Wylie Head: The paper "Supervisory Control and Telemetering as Cost Reduction Tools" did not intend to convey that supervisory control and telemetering had never been used by the steel industry. The paper did recognize the fact that in the past there has not been the economic necessity for this type of equipment. Increasingly higher operating costs of recent years have been the reason for the trend towards greater and greater use of this type of equipment.

In his discussion Mr. Derr referred to one type of impulse supervisory control as made by his company. The paper attempted to cover the two systems of impulse supervisory control available today. The system sponsored by Mr. Derr uses the number of impulses as the intelligence in the signal, whereas the other system depends upon the variation in timing between impulses. Both systems employ a check back signal because they cannot be certain that the signal will arrive ungarbled at the remote station and that the remote station equipment will correctly interpret this signal. We thus see that the check back signal is a necessary evil with the impulse systems of supervisory control, because the remote control signal cannot be depended upon to make the correct selection under all conditions. The same factors that might garble a remote control signal can also be present to garble a check back signal, and for this reason the check back feature does not provide the reliability that it appears to.

If a system of control can be depended upon to always make the correct selection, there is absolutely no need for the inconvenience of a check back signal.

The audio sequence method of supervisory control has shown in both theory and extensive application that it can be depended upon to correctly select the desired operation. It uses a positive type of control signal that can be depended upon to properly select the desired unit and therefore operate the required unit without the waiting interval of a check back signal. This results in fast and accurate supervisory control. The only lamps or signals that the operator is concerned with is the changing lamps that tell him that the unit he has selected has actually operated. This is provided in the "proof of operation" of the audio sequence type of supervisory control.

The author agrees with Mr. Derr in his statement that accuracy of operation and indication is of prime importance in supervisory control equipment. It is also agreed that the elimination of any feature which inherently detracts from accuracy is not justified. It seems equally obvious that a system of control that is in itself inherently accurate is preferable to one that requires the equipment to check itself before the equipment can be trusted to operate remote equipment.

Nearly all systems of supervisory control depend to a large extent upon telephone type relays. The audio sequence method of control uses telephone relays to a large extent, but uses other types of equipment where it can be demonstrated that these other types of equipment will do a better job. Designers of this system follow the theory of using the best that is available irrespective of traditional use.

Mr. Derr infers a high degree of reliability for the telephone type relays used in his system and a low degree of reliability for the frequency responsive relays used in the audio sequence system. The audio sequence system uses both telephone relays and vibrating reed frequency responsive relays. In practice the vibrating reed relays have shown less tendency to give trouble than the telephone relays associated with them. These frequency responsive units are mechanically tuned vibrating reed units and have a ruggedness that gives dependable operation year in and year out.

Regarding the list of advantages claimed by Mr. Derr for the use of d-c signalling over the audio tones used by the audio sequence method of control, I wish to take the following exceptions:

1. Before a selection can be made on equipment using the audio sequence method of control the following requirements must be met; (a) A definite number of audio frequency tones must be received consisting of (b) audio frequencies of specific frequencies appearing in (c) a definite restrictive sequence or combination with (d) definite intervals between the various audio tones. In order for a selection to be made on the impulse system all that is necessary is a collection of impulses. It is easy to see that it is easily possible for a signal to be induced on a control line that would operate the impulse system equipment, whereas it is almost inconceivable that a signal would be induced on a control circuit that would operate the audio sequence equipment.

Good supervisory control equipment is designed to operate over the circuits available without false selection due to induced signals.

2. Properly designed supervisory control equipment should not have signals that will interfere with services on adjacent circuits regardless of the type of circuit used. All audio sequence systems of supervisory control use signal levels that are considered safe by the various telephone companies throughout the country.

3. I cannot see that the use of vacuum tubes in the signal generator of the audio sequence method of control is a valid objection, considering the vast amount of vital and important equipment in use today throughout the world that depends upon vacuum tubes for its successful operation. Mr. Derr states that his system can operate over power line carrier, which is also true of other systems. Power line carrier depends upon vacuum tubes and was not practical until reliable vacuum tubes were developed.

4. Mr. Derr's fourth advantage that he claims may be true in theory, but is very seldom if ever true in actual practice. Cable circuits of the length mentioned by Mr. Derr are seldom available on applications involving supervisory control. In the few cases where this condition may occur, we find that other services being used on the cable will require the use of repeaters or loading circuits.

The audio sequence method of control is custom built to provide correct operating equipment for the problem at hand and to provide a grouping of components to meet the specific requirements of the problem. The author has yet to see a supervisory control problem that can be solved by the use of the impulse system of supervisory control, and cannot be solved by the audio sequence method of control. He has seen some problems involving remote control and telemetering where the audio sequence method of control could meet the problem better than the impulse system.

The audio sequence method of control can quite easily be operated over single frequency power line carrier channel. It has also been used over micro wave radio.

The Bell Telephone probably had very good reasons for using d-c impulses in their dial selection. It should be pointed out that very little damage, if any, will result if a wrong number is obtained in dialing operations, whereas very serious damage can result if the wrong number is obtained on supervisory control selections. The audio sequence method of control was developed by engineers who specialize in supervisory control equipment exclusively, and by a company that manufactures this type of equipment almost exclusively. This group of engineers probably has more experience in the design of supervisory control and related equipment for diversified application than any other group of engineers in existence today.

REPORT OF CAMBRIA COUNTY, PA. COAL TESTS

▲ MOST of the coals from the four principal beds of Cambria County, Pa., can be brought up to metallurgical standards by mechanical cleaning alone or in conjunction with fine crushing.

These conclusions are based on the results of Bureau of Mines float-and-sink tests of samples collected at 14 mines throughout the county. Only one of the samples failed to respond to the upgrading treatment. This was from the Lower Freeport coal bed.

The bureau tests and their results are presented in detail in a bureau report. They were made in connection with the program of inventorying the Nation's known minable reserves of coking coal begun in 1948 at the request of the Munitions Board, Department of Defense, because of concern over the rapid depletion of premium-grade coking coals. The program is being carried out on a county-by-county basis, and is divided into three phases: (1) determination from available data of coking coal reserves in beds thick enough and near enough the surface to be economically minable by present methods, plus those that might become economically minable with improved technology; (2) study of the preparation characteristics of the reserves thus developed to determine which are suitable under present standards for producing metallurgical coke either as mined or after upgrading by conventional preparation methods, and which would require special and more intensive preparatory treatment, and (3) study of the carbonizing properties of the coals to determine the yield and quality of coke, gas, and chemical products that can be obtained by carbonizing them singly or in blends.

The new report on Cambria County covers phase 2 of the program, phase 1 having been covered by a report issued a few months ago. It is the first county report on coal preparation characteristics issued in connection with the coking-coal survey.

The principal reserves of coal remaining in Cambria County are in the Upper Freeport, Lower Freeport, Upper Kittanning, and Lower Kittanning beds, the report notes, with the Lower Kittanning yielding nearly 60 per cent of the county's output. The main washing problem in the preparation of Cambria County coals for metallurgical use is to reduce the sulfur content, which in most instances can be done.

Test data show that the Kittanning coals repond readily to fine crushing for the removal of sulfur impurities, but that the Freeports, especially the Upper bed, are not very responsive to this method of beneficiation. The report includes complete float-and-sink data on 16 tipple samples, shown by washability tests, and tabulation of similar data on 15 face samples.

A free copy of Report of Investigations 4747, "Preparation Characteristics of Coal Occurring in Cambria County, Pa.," by William L. Crentz, Bureau coal technologist, and Fern Steele, Bureau technical assistant, can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

19-Stand Rod Mill of

KEYSTONE STEEL AND WIRE CO.

. . . . by two-stranding the roughing mill and four-stranding the remainder, production of the mill has been increased 150 per cent . . . .

By WILLIAM HERMAN
Superintendent of Rolling Mills
Keystone Steel & Wire Co.
Peoria, Ill.

▲ THERE are many rod mills throughout the country and all of them different. To the best of my knowledge, there are no two mills in existence that are exactly alike.

They vary in many ways, in the number of stands and in the way they are arranged. Some have a total of 14 stands, others have 23 stands or more. Some are straightaway without loops, others have 2, 3 or 4 and on up to 6 or 8 loops in the Garrett mills. They vary in size and speed, in the arrangement of the drives, the amount of tonnage they will produce, and in many other ways.

Naturally the Keystone rod mill is also different from all others in several respects. This paper will deal mainly with these differences. This mill is a 19-stand mill with two loops. See Figure 1. This is a fairly common arrangement, but the outstanding difference lies in the fact that there are only two bars in the first 9 stands, and as many as four bars in the last 10 stands simultaneously, with an average of three bars continually. It is common practice to 3-strand a mill to increase tonnage, but when this is done, it is three stranded from the first stand to the last, which will never give quite three bars continually. Due to the crop at the flying shear, and the gap in feeding the billets into the mill, the result will be something less than a three bar average. Keystone has developed a method whereby the average can be increased to 3, 3½ or 4 bars if desired.

We now have a 480-lb billet which gives a 3 bar average. This could be increased to 3½ bars by reducing the weight of the billet 100 lb and increasing the speed of the rougher 15 per cent. There is a definite relationship between billet weight, rougher speed, and loop length. The heavier the billet the slower will be the speed, conversely the lighter the billet the higher the speed to maintain a given loop length. The tonnage is directly proportional to the speed of the rougher; therefore, it would be desirable to run the rougher as fast as possible to obtain the maximum tonnage, however, the weight of the billet must be considered also. It may be desirable to have smaller coils and more tonnage, or larger coils and less tonnage. We have chosen a 480-lb coil and a 3-bar average. Theoretically, this principle can be carried to a point where a four bar average would be reached. This would require the use of 6 passes in the last 10 stands, or a twin finisher with 3 passes in each and 6 reels instead of 4. A 3½ bar average is the maximum that can be handled with 4 passes and 4 reels. A 3½ bar average calls for a roughing mill constant which is 3½ times the constant of the finishing mill, or 1124 instead of 985 as at present.

It may be advisable at this point to explain what is meant by the constant. There are several constants used in mill calculations such as area times length and area times feet delivered per minute, but the constant most frequently used consists of three factors, RPM × WD × Area. The constant of one stand must equal the constant of the next stand, except where loops occur. The constant times pi (3.1416) will give the cubic inches delivered per minute, and this multiplied by 0.2835 (wt of a cu in. of steel) will give the pounds delivered per minute. Pi × 0.2835 equals 0.89 so the pounds delivered per minute is actually 89 per cent of the constant. In other words, the constant represents a figure which is 11 per cent higher than the pounds delivered per minute per strand. To obtain the total constant or the total pounds per minute, it is necessary to multiply by the number of strands.

If the constant of the rougher is 985 as shown in Figure 2, and there are two strands, the rougher will deliver 1753 pounds per minute. The pounds delivered by the finisher must equal the pounds delivered by the rougher, but the amount the finisher puts out is only 571 pounds per strand. It takes a 3.07 bar average in the finisher to deliver the same as the rougher. This average is maintained by having 2, 3 and 4 bars in the mill at times. In other words, the rougher delivers 53½ per cent more steel than the rest of the mill can handle in two strands. This excess is thrown into long loops on a looping floor, 120-ft long. These loops start from zero and reach their maximum length in 33 seconds, traveling down the floor over the turtle backs at the rate of 3½ feet per second until the ends drop out of the roughing mill. By this time, there is approximately 240 lineal feet in each loop or 165 lb per strand. Two loops reach the maximum at approximately the same time that the two succeeding bars enter the intermediate mill. In this way the intermediate and finishing mill are working on the tail ends of two bars, and the front ends of the two just entered, thus filling the four passes for a time and averaging slightly over three bars continually.

The following will cover the history and description of the Keystone rod mill and show how this principle was developed which makes this mill so different from others.

In 1917, a 16-stand, 10-in. continuous rod mill was

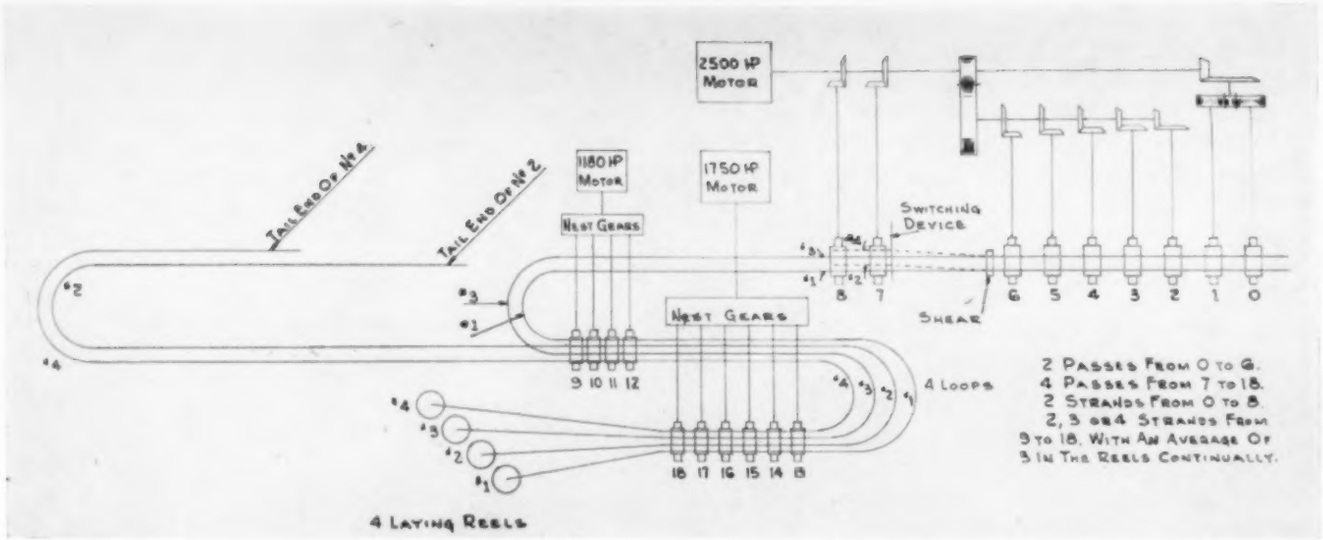

2500 HP Motor
1180 HP Motor
1750 HP Motor
Tail End Of No 4
Tail End Of No 2
Next Gears
Switching Device
Next Gears
Shear
9 10 11 12
4 Loops
18 17 16 15 14 13
4 Laying Reels
2 Passes From 0 to 6.
4 Passes From 7 to 18.
2 Strands From 0 to 8.
2, 3 or 4 Strands From 9 to 18. With An Average Of 3 In The Reels Continually.

Figure 1 — This shows the general layout of the Keystone, 19-stand, rod mill and illustrates how a two-strand rougher can be used to increase the number of strands to four in the intermediate and finishing mill. This is accomplished by speeding up the rougher to create a long loop between stands 8 and 9. Bars No. 2 and No. 4 come around the repeater and enter stand 9, then jump out of the groove and form a loop that travels rapidly down the looping floor until they reach a maximum length of 120 ft. At this point the bars leave the roughing mill and the loops are pulled up against the turtle backs by the intermediate mill. In the meantime, bars No. 1 and No. 3 have come around the repeater and have entered stand 9 and are starting to form two more loops. This puts four bars in the mill until loop No. 4 runs out. Then there will be three bars in the mill until No. 2 runs out. There will then be an interval with only two bars in the mill. When loops No. 1 and No. 3 have reached the maximum, No. 2 and No. 4 will be entering stand 9 and this cycle will be repeated averaging 3 bars continually.

The bars are conveyed across the 20-ft gap between stands 6 and 7 by two open side pipes. When bars are passing through the pipes, the open side is up. As soon as they enter stand 7, the pipes are turned 180 degrees which puts the open side down. While in this position, they are lifted off of the bars in passes 1 and 3 and dropped into place to line up with passes 2 and 4. They remain in this position until bars No. 2 and No. 4 have entered stand 7. By this time, bars No. 1 and No. 3 have run out; then the pipes are shifted back to passes 1 and 3 again to receive the next two bars.

In case of a cobble in pass No. 1, the bar is cut at the flying shear and enters pass No. 2. In this way, the cobble is bypassed and the balance of the bar goes to reel No. 2. The same applies to passes 3 and 4. This shifting from one pass to the other is done mechanically and is controlled by the feeder who makes the switch immediately after the two bars have entered stand 7. The pipes are then in position to take the next two bars or to bypass cobbles as the case may be.

built for Keystone. It was designed to use a 1¾ in. billet 30 ft long. The original equipment included two gas producers which supplied producer gas for the 25 ft × 30 ft furnace. The mill was designed to produce 400 net tons of 5 gage rods per day, which it did eventually. It operated this way for several years until the demand for rods increased. The original design was a 2-strand mill from No. 1 to 16, with two short loops, one between stands 10 and 11 and the other between 12 and 13.

In an attempt to increase the tonnage, the large reduction gears were replaced with another pair of higher ratio which increased the speed of the first 6 stands about 20 per cent. The object of this move was to create a loop between stands 6 and 7 and repeat between these stands. By repeating a heavier bar here, a loop of 65 ft would give the same results as a 120 ft loop between stands 8 and 9. This idea has a lot of merit and might be done successfully today, but at the time this was tried 25 years ago, the method employed resulted in failure. So it became necessary to abandon this idea and go back to the original set-up. The large reduction gears were taken out and the original pair installed.

While this looping experiment resulted in failure, it did establish the principle of using four passes from stand 7 to 16 which later led to a great increase in production. It was responsible for a slight increase immediately, because it required no space between billets when feeding them into the mill. With the former arrangement it was necessary to allow considerable space between billets to prevent the incoming billet from catching up with the previous billet on the repeaters before the pass was clear. With four passes from No. 7 on, this could never happen. By feeding the billets as closely as possible, they were actually lapping slightly from stand 11 throughout the rest of the mill. This resulted in having three bars in the finishing mill for short periods at a time. The possibilities for increasing the output by this means were not immediately recognized. Here was a potential increase that was not made use of for quite some time. It eventually dawned on someone that this overlapping of the bars could be carried further by increasing the length of the loop. To accomplish this, the first 10 stands (The roughing mill) would have to be speeded up to create the longer loop. The high speed reduction gears used in the first looping experiment were used again to increase the speed of the first 6 stands, and the roll diameters were increased in stands 7, 8, 9 and 10 to get the desired feet per minute.

The original looping floor was only 10 ft long, a section 30 ft long was added making it possible to use a loop 40 ft long. This worked out as expected and resulted

in having three bars in the mill for longer periods with a corresponding increase in tonnage. The next move to step up production was the addition of two stands to the finishing mill. Stands 17 and 18 were added which made it possible to open up the rougher and let more stack through in a given time. The tonnage increase was directly proportional to the increase in the area of the bar delivered by stand 10, in other words, proportional to the increase in size of the bar delivered by the roughing mill.

After making the gear and diameter changes mentioned previously, the roughing mill was slowed down to maintain a loop of 40 ft. The extra loop length worked so well that another section was added to the looping floor, and the motor was then run at a higher speed to increase the loop length to 60 ft with a further increase in tonnage.

We were feeling our way to see how far we could go with this idea. It developed that in several more steps we finally increased the loop length to 125 ft, and this brought the motor up to top speed which was as far as we could go. With loops of this length, there were three and four bars in the mill at times with an average of three bars continually. This was a long way from the original layout in which the billets had to be spaced properly to avoid lapping up to the point, where they were lapping enough to have the equivalent of three bars in the mill all of the time.

The next move was to speed up the finishing mill by increasing the size of the belt drive pulley. Increasing the finishing speed shortened the loop. This made it possible to use a larger billet (1⅞ in.) which in turn lengthened the loop again to the maximum of 125 ft. This, however, added nothing to the tonnage unless one considers the very slight increase due to feeding a lesser number of billets which results in a few less feeding gaps. This move was made primarily to increase the size of the coils.

The combined increase from all of these changes had brought the tonnage up from 400 tons per day to 800 tons per day. The tonnage had been doubled, and the furnace was being crowded to the limit. About this time natural gas became available so the gas producers were discarded and gas was used for heating.

The mill operated this way for several years more before any further changes were made. In 1944 a new heating furnace was built. Previous to this (1941), a plan was conceived whereby the tonnage could be increased by 20 per cent or more. This plan envolved a major change, part of which was the addition of another stand of rolls ahead of No. 1 stand. When the new furnace was built in 1944, space was left for the new stand to be added later.

The furnace was made larger, 36 ft × 42 ft inside dimensions and was designed to heat 60 tons or more per hour. It is equipped with burners which can use natural gas or oil, and the switch from one fuel to the other can be made in a few moments by shutting off one fuel and turning on the other.

The plan conceived in 1941 was finally installed in November, 1948. The basic principle responsible for the 20 per cent increase was the new arrangement of the stands, which made it possible to speed up the roughing mill again. Stands 9 and 10 were taken out of the rougher train and placed in front of 11 and 12 in the intermediate mill. We formerly repeated from 10 to 11 stand, we now repeat from stand 8 to 9.

In effect, when we moved stands 9 and 10, we let the rougher run. This changing of the stands in itself would have accomplished little or nothing in the way of an increase in tonnage. The only effect of this move was to shorten the loop from 125 back to 10 ft, where it was in the beginning. It is obvious that the loop would be much shorter by repeating out of stand 8 than if repeated out of stand 10 which has a much higher delivery speed.

Now we have an 800-ton mill with a short loop, so we do exactly what we did 25 years before when we had a 400-ton mill with a short loop. We speed up the rougher again and build the loop up to the maximum once more. Speeding up the rougher could have been done by gear changes as before, but the extra speed was obtained this time by rewinding the motor. The motor was over 30 years old and was due for a rewinding anyway. It was a 22-pole machine to begin with and by rewinding, it became a 20-pole machine with more speed and more power.

By simply moving two stands and rewinding a motor, a 20 per cent increase was made. This sounds very simple, but the actual accomplishment was far from being as simple as that. The mill was down nearly two months to make the necessary changes. The belt drive was replaced with modern roller bearing gear units, a new stand of 14 in. was installed ahead of No. 1 stand with its driving mechanism, and a new gear unit for stand 7 and 8 was installed. The 700-hp motor driving 11 and 12 stands was replaced by the original finishing mill motor to drive stands 9, 10, 11 and 12, and a new motor was installed to drive the finishing mill. The motor room was enlarged to accommodate the new equipment and the old reels were replaced with four new laying reels. About 600 cubic yards of concrete were poured for new foundations and walls.

The mill started up on November 6, but it was not until January that tonnage began to pick up and show what could be done with this new layout. On January 10, a record run of 1029 tons was rolled in 24 hours. In February, 364 tons were rolled on one 8-hour turn. The mill is capable of averaging 950 tons per day.

The entire mill is housed in a building 80 ft wide by 225 ft long. This space includes the motor room, furnace, mill and roll shop. It is very compact and requires an unusually small amount of floor space. We have ample room for operations, but are lacking in space for spare parts and supplies. There are mills that produce more than this one, but have four or five times the floor space.

It is essential in a mill of this type to have proper co-ordination between the feeder, shearman and reelman. They must know at all times, which passes and reels are being used and which are idle. This is accomplished by an intricate system of lights of various colors. The course of each bar through the mill is clearly indicated to all concerned. There are 4 lights in front of the feeder, one for each pass. They can be turned on or off from three different places in the mill, from the intermediate mill, the finishing mill and from the reelers' pulpit. When the finisher wants to change a guide or work on a pass, he signals the feeder to hold up by turning on the proper light. The reelman can signal the

feeder and shearman the same way in regard to the reels. There are three other groups of 4 lights each, located in different parts of the mill to keep the crew properly informed at all times. In addition to this there is a device in front of No. 9 stand which operates as follows: When a cobble occurs in the intermediate or finishing mill, this device automatically operates a shear which cuts the bar, blows a whistle, and turns on a light all at the same time. At the sound of the whistle, the flying shearman cuts the proper bar as indicated by the light and the bar is switched to an open pass and to the empty reel. This bypasses the cobble and saves the balance of the billet. When the whistle blows, the scrap men run to the repeater and drag the loop which is now cut and free at both sides to a scrap bailer located at the end of the looping floor. The light serves as a signal to the feeder and shearman that this particular pass is blocked and feeding is stopped till the pass is clear. It frequently happens that the bar which is trying to bypass the cobble also cobbles. In this case, the automatic shear operates again, cuts this bar, blows the whistle and turns on the light for this pass. There being no more open passes, the feeder cuts the billet at the furnace, the flying shearman cuts and drags about 100 ft of the No. 6 bar out on to the floor. This clears the roughing mill. The scrapmen clear the repeater and the rest of the crew rush to the stand where the cobbles occurred. Everybody does something, and soon all is clear again. When this occurs, it resembles a 33-alarm fire and produces plenty of action for a while. The 6 square which was pulled out on the floor is later taken out to the yard and converted into concrete reinforcing bars. When tension is applied to a bar while it is being twisted, it becomes perfectly straight regardless of how crooked it may have been in the first place. The No. 6 cobbles are handled in this way and make a saleable bar, and have also been used in our own construction for years.

Every bar that goes through the mill is a potential cobble. When the bar enters a pipe at No. 9 stand it makes an electrical contact which starts a time relay in motion which in turn operates the automatic shears

Figure 2 — This is a data sheet for the mill showing speeds, feet per minute, diameter, areas, etc.

19 STAND ROD MILL OF KEYSTONE STEEL & WIRE CO.

STD.	R.P.M.	W.D.	AREA	CONSTANT	RED. %	C %	FPM FT. ENT.	FPM FT. LVG.	TIME IN STAND SECONDS	O.D.	DEDUCT FROM O.D. FOR W.D.	DIAM. PATTERN	L_1 LENGTH ENT.	L_2 LENGTH LVG.	WT. LBS. PER FOOT	R.P.M. x W.D.	R.P.M. MOTORS	GEARS	DIAM. RINGS AND SIZE OF SQ.
0	207.1	13.406	3.5477	985	24.52	75.48	54	72	32.81	14.594	1.1875	14"	30	40	12.062	277.638	450	$\frac{20}{150} \times \frac{29}{126}$	BOX PASS
1	322.2	13.480	2.2679	"	36.08	63.92	72	114	"	14.062	.582	14"	40	62	7.711	434.326	"	$\frac{20}{150} \times \frac{37}{81}$	OVAL
2	561.3	11.968	1.4663	"	35.35	64.65	114	176	"	12.640	.672	12"	62	96	4.985	671.764	"	$\frac{31}{115} \times \frac{29}{58}$	1.21" SQ.
3	842.4	12.446	.93948	"	35.93	64.07	176	274	"	12.181	.335	12"	96	150	3.194	1,048.45	"	$\frac{31}{115} \times \frac{31}{62}$	OVAL
4	1189.9	12.451	.65986	"	29.76	70.24	274	391	"	12.815	.474	12"	150	214	2.2435	1,492.75	"	$\frac{31}{115} \times \frac{45}{47}$	.812" SQ.
5	1601.6	13.545	.45405	"	31.19	68.81	391	568	"	13.718	.173	13"	214	310	1.5438	2,169.37	"	$\frac{31}{119} \times \frac{35}{45}$	OVAL
6	2146.6	13.375	.34307	"	24.44	75.56	568	752	"	13.688	.313	13"	310	411	1.1664	2871.08	"	$\frac{32}{115} \times \frac{33}{42}$	.585" SQ.
7	3308.8	11.245	.26294	978	23.35	76.65	747	974	33.04	11.406	.161	11"	411	536	.8940	3720.75	"	$\frac{20}{68}$	OVAL
8	4267.2	11.286	.20315	"	22.74	77.26	974	1261	"	11.593	.307	11"	536	694	.6907	4815.16	"	$\frac{20}{68}$	.501" RD.
9	3294.9	11.258	.17556	651	13.58	86.42	839	971	49.64	11.375	.117	11"	694	803	.5969	3,709.40	540	$\frac{45}{64} \times \frac{36}{45}$	OVAL
10	4118.6	11.317	.13967	"	20.42	79.58	971	1220	"	11.563	.246	11"	803	1010	.4749	4661.02	"	$\frac{43}{64}$	.422" RD.
11	4860.0	11.674	.11474	"	17.85	82.15	1220	1485	"	11.750	.076	$11\frac{1}{3}$"	1010	1229	.3901	5673.56	"	$\frac{43}{50}$	OVAL
12	6075.0	11.672	.09181	"	20.00	80.00	1485	1856	"	11.875	.203	$11\frac{1}{3}$"	1229	1536	.3122	7,090.74	"	$\frac{43}{50} \times \frac{48}{56}$	.342" RD.
13	7654.1	10.826	.07147	642	15.61	84.39	1830	2169	50.33	10.890	.064	11"	1536	1820	.2634	8286.33	835	$\frac{48}{72}$	OVAL
14	9185.0	10.597	.06595	"	14.87	85.13	2169	2548	"	10.765	.168	$10\frac{2}{3}$"	1820	2138	.2242	9,733.34	"	$\frac{66}{60}$	.290" RD.
15	10567	10.893	.05672	"	15.52	84.48	2548	3016	"	10.953	.060	11"	2138	2531	.1894	11,521.2	"	$\frac{26}{60}$	OVAL
16	12443.1	10.962	.04706	"	15.54	84.46	3016	3571	"	11.109	.147	11"	2531	2996	.1600	13640.1	"	$\frac{26}{57}$	.245" RD.
17	14255.5	11.511	.04154	"	11.74	88.26	3571	4046	"	11.578	.067	$11\frac{2}{3}$"	2996	3394	.1412	15,454.1	"	$\frac{23}{51}$	OVAL
18	14568.1	11.883	.03708	"	10.73	89.27	4046	4532	"	12.015	.132	$11\frac{2}{3}$"	3394	3803	.1260	17311.3	"	$\frac{43}{49}$	.217" RD.

$2\frac{3}{16}$" BILLET x 30 FT. LONG - WT. PER FT. = 16# - AREA = 4.70$^{in^2}$ - BILLET WT. = 480# - YIELD $36\frac{1}{2}$% - COIL WT. = 463#

TONS PER HR. = 100% EFF. = .0267 x CONST. x NUMBER OF STRANDS = .0267 x 985 x 2 = 52.6

.217" DIAM. ROD.

LOOP NO. 1 = 116 FT.

LOOP NO. 2 = 11 FT.

AVE. NUMBER OF BARS IN FIN. MILL = 13.07

ROUGHING MILL MOTOR 400 - 450 R.P.M.

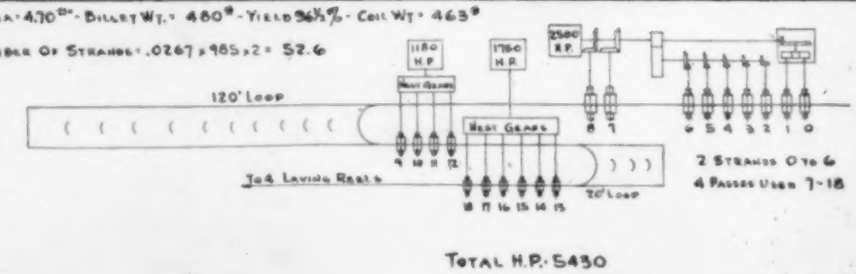
INTERMEDIATE " 336 - 540 "

FINISHING MILL " 560 - 900 "

O.D. REELS = 46"

I.D. " = 34"

79 K.W.H. PER TON



TOTAL H.P. 5430

after a given time. If the bar gets through the intermediate and finishing mills without cobbling, the relay is tripped again by the bar and nothing happens. If it cobbles in either of these mills, it does not get through to trip the relay then the shear will operate, cut off the bar, blow the whistle and turn on a light as has been described.

To cool the rods properly and to reduce the amount of scale so that they may be cleaned with the minimum amount of acid, they are run through pipes under high pressure water (140 psi). This chills them quickly and reduces the scale. If this cooling is done too quickly, the front end of the rod for about 2 feet back will become exceedingly hard and stiff and can not be bent with the hands. This is true regardless of the analysis of the rod. Low carbon as well as high will be affected this way. These stiff ends striking the bottom of the reels with ramrod effect refuse to lay properly and will cause cobbles in the reel pipes.

To avoid this condition, the water valves are operated electrically by contact of the rod in the pipe and through a time relay which is set to allow a ring or two of hot rods to come through before the water is turned on. When the rod leaves the pipe, the water is shut off. This cycle is repeated again when the next rod comes through. By this system, the maximum amount of water can be used and the acid consumption kept down to the minimum.

The question has been asked, "Why not increase the tonnage by speeding up the finishing mill?" The answer is that this would have no effect on the tonnage whatsoever. More speed would simply shorten the loops and reduce the average number of bars in the mill. If this were carried to the extreme, there would be no loops at all. Then the finishing mill and roughing mill constant would be equal with two strands only from 0 to 18. To obtain this condition the finisher would have to run 50 per cent faster and still not increase the tonnage one bit. This then would be equivalent to a two strand straight away mill with a delivery speed of 6937 fpm. Most anyone will agree that this is some speed for a rod mill. This points out clearly in a few words what a long loop will do to increase tonnage. In the final analysis, the long loop is responsible for it all. The greater the area of the bar in the loop, the greater the increase will be, and the shorter the loop will be for a given increase. That is the basic principle employed in this mill that has increased the output from 400 to nearly 1000 tons per day.

The principle of two stranding the roughing mill and four stranding the rest of the mill has been responsible for an increase of 150 per cent. This is a sizeable increase and thoroughly proves the value of this method.

The purpose of this paper was to bring out the points in which this mill differs from others. We believe that these points have now been covered so this brings the paper to a close.

There are some simple mathematical formulas included for reference and these are given in the following paragraphs.

Symbols used in formulas:

A_1 = Area entering
L_1 = Length entering
F_{M1} = Fpm entering
T = Time in stand (sec)
WD = Working diam
Con = Constant
Rpm = Rev per min
C% = Complement of reduction, %

$$\frac{\pi}{12}=\frac{3.1416}{12}=0.2618$$

A_2 = Area leaving
L_2 = Length leaving
F_{M2} = Fpm leaving

$$\text{Con}=\text{Rpm}\times\text{WD}\times A_2$$

Cu in. delivered per min = Con $\times$ 3.1416

Pounds delivered per min = Con. $\times$ 3.1416 $\times$ 0.2835 = 0.89 Con

$$\text{Tons per hr}=\frac{60\times 0.89\ \text{Con}}{2000}=0.0267\ \text{Con}$$

$$A_1 L_1 = A_2 L_2$$

$$A_1=\frac{A_2 L_2}{L_1}$$

$$L_1=\frac{A_2 L_2}{A_1}$$

$$A_2=\frac{A_1 L_1}{L_2}$$

$$L_2=\frac{A_1 L_1}{A_2}$$

$$F_{M1}=F_{M2}\times C\ \%$$

$$F_{M2}=\text{Rpm}\times\text{WD}\times 0.2618$$

$$\text{Rpm}=\frac{\text{Con}}{\text{WD}\times A_2}$$

$$\text{WD}=\frac{\text{Con}}{\text{Rpm}\times A_2}$$

$$A_2=\frac{\text{Con}}{\text{Rpm}\times\text{WD}}$$

$$\text{Loop length}=\frac{(F_{M2}^{\,8}-F_{M1}^{\,9})T^{\,8}}{120}$$

8 and 9 refer to stand numbers

$$C\ \%=100\%-\text{Red}\ \%$$

$$R\ \%=\frac{A_1-A_2}{A_1}\ \text{or}\ 100\%-\frac{A_2}{A_1}$$

$$T=\frac{60\ A_1 L_1}{A_2\ F_{M2}}$$

$$T=\frac{60\ A_1 L_1}{0.2618\ \text{Con}}=\frac{229.18\ A_1 L_1}{\text{Con}}$$

Use billet area and billet length

FIRE PROTECTION FOR

. . . . it may often be better to get a motor wet than to take the chance of losing it completely should it catch fire . . . .

▲ THE frequency of electrical fires in the statistics developed by Fire Insurance Actuarials indicates a steadily growing figure. The size of each loss is also increasing, making the total fire damage from electrical causes one of the greatest single causes of fire losses today.

Starting with the transformer, we will attempt to analyze some of the fire protection and extinguishing requirements suggested by the insurance carriers for the control and reduction of this tremendous fire waste. We will assume that the transformers are installed having proper electrical protection, such as adequate high voltage fuses or adequate capacity circuit breakers set to operate at not over 200 per cent of the transformer rating.

Our first protection against fire loss in self-cooled oil insulated transformers is the location of the transformer, both in respect to other transformers as well as adjacent property. Transformers under 75 kva located outside of buildings should be located not less than 10 ft from the building. This 10-ft spacing should be provided whether the transformer is located on the ground, on poles or on platforms. Transformers with a rating up to 333 kva should be located not less than 20 ft from the buildings, and transformers above this size should be located 30 ft away from the buildings and installed on a concrete mat which is suitably drained or curbed to provide for the oil contained in the transformers.

Transformers having a primary voltage of less than 600 v and a capacity of not over 10 kva may be installed within the buildings, provided there are no combustible materials in the immediate vicinity of the transformer.

Transformers of not over 600 v and not more than 25 kva in any one unit, or not more than 75 kva, may be installed in the building without providing a vault, providing the transformers are surrounded by a concrete curb of not less than 6 in. high, forming a basin which will retain all liquid in the transformers.

Transformers of more than 600 v primary and more than 25 kva in one unit, should be located in a fire-resistive vault built in accordance with the code specifications.

It is important to segregate transformers from each other as far as practical. In the smaller sizes, under 75 kva, a curb of at least 8-in. high with individual trapped basins may provide a reasonable segregation. In larger units, masonry walls or cells are recommended to obtain maximum isolation.

In transformer banks located outdoors, it is advisable to separate the transformers in circuits so that an accident in one group will not involve the second. Single phase transformers of one circuit should be isolated from each other if practical. It is realized that there are many transformer installations that are not installed according to these schedules, and there are many locations where these applications cannot be applied due to available space. There are many innovations that can be adapted such as providing a blank wall against transformers that cannot be located a safe distance from the building, replacing windows with steel sash and wired glass where window openings are necessary, and, in some cases, replacing the windows and sash with glass brick. Other installations have been protected by the use of automatic sprinklers using a dry pipe system to provide automatic protection the year around.

This practice of extending automatic sprinklers over transformer banks is becoming more and more popular. In some of our larger manufacturing concerns, particularly in the chemical industry where continuous operation is paramount, it is one of the standard protection practices today.

One of the features frequently omitted is the proper venting of transformers which are located inside the buildings. It is important that the vents on the transformers be connected to the outside, particularly where transformers of 25 kva or larger are located in the buildings, either in vaults or in building proper. The venting of transformers filled with non-flammable dielectrics at ordinary temperatures is even more important than the venting of oil filled transformers, as the gases generated by the breaking down of this fluid may be highly toxic. The manifolding of vents from transformers is permitted and frequently simplifies the adequate venting.

The use of dry type transformers instead of oil filled units offers considerable advantage in safety as well as economy of installation. These transformers may be installed inside buildings without constructing a vault or special drain area and only segregated by a grille or barrier to prevent personal injury from unauthorized access. In new installations, the advantages of the dry transformer should be considered and the economy of installation calculated against the slight additional cost of the equipment.

The causes of failures in transformers are many, and sometimes rather difficult to determine. Probably the greatest cause of transformer failures is by lightning, either induced or a direct stroke. The installation of transformers naturally is assumed to embody all of the accepted lightning protection which is well designed and standardized at the present time.

Switching surges frequently cause as high a voltage pressure on electrical equipment as high as lightning surges and it is frequently difficult to determine if the failure is from one or the other. The protection of both, however, is through similar equipment.

Dirty insulator bushings will frequently cause the failure of the transformer, also allowing the oil to become contaminated or sludge to accumulate. Low oil level and accumulation of water through natural breathing will frequently cause the failure in this equipment. There is always the tendency toward overloading the transformer and with the age increasing on most of this type of equipment, the coil insulation is eventually headed for a breakdown and failure. Overloading definitely reduces the life span.

For the protection of transformers, both in the open

ELECTRICAL EQUIPMENT

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and in vaults, we frequently recommend the installation of automatic water spray for this equipment. Many of the water spray systems protecting transformer banks are in use today, and have proven to be of value in the continuity of service, especially in transformer banks of strategic value.

Many of our larger utility companies, particularly through Ohio, have adopted a standard of protecting their transformer banks in the open with automatic water spray systems, and there have been a number of cases where the operation of this water spray system has assisted in keeping the service of these utility companies unbroken.

There has been in the past, some disturbance in the mind of engineers concerning the hazard of throwing water on high voltage electrical equipment. Tests of the conductivity of water spray have been made by several reliable laboratories and public utility companies. The results indicate that voltages up to 7500 v will transmit a current only 6 in. through water spray, 15,000 v can be transmitted but 12 in., and 25,000 v only 17 in. This distance increases about, in direct proportion, up to voltages of 220,000 v which will transmit current only 124 in. through water spray. It can be clearly seen from these distances that the hazard of causing a flashover by the use of water spraying is relatively negligent.

Some of our larger manufacturers and most utility companies use a solid stream of water to clean off the insulators on their high voltage lines. In these cases, insulators on 220 kv lines are washed with the grounded nozzle, not over 17 to 20 ft away without incident.

Oil switches or oil filled circuit breakers offer considerably more fire possibilities, and frequently a more critical fire damage than transformers. While it is sometimes possible to borrow transformers from the public utility company or other locations, or make emergency connections to restore production, for oil switches and oil circuit breakers, emergency service is considerably more complicated.

As with transformers, the greatest protection appears to be segregation or separation between oil switches and other electrical equipment such as the feeders and control panel.

The seriousness of oil switches and circuit breaker hazards is increased by the constant trend of increasing power supply to circuits that were originally designed for a much lower capacity. This situation I know is familiar to all who have had anything to do with power distribution during the last decade.

That is probably one of the greatest worries of the insurance carriers today. We realize that a great majority of the industrial plants have oil-filled switches and breakers that were installed when the capacity of the system was very much lower than it is today. We, probably as well as the owners of the property, are sitting with fingers crossed, hoping that they are not called upon to open under a full load. We frequently do have them open under a full load with the inevitable results that the circuit breaker or switch is blown apart, and sometimes a serious fire results.

There have been many subterfuges invented by distribution engineers, such as cascading operating sequences or even removing the automatic operation of circuit breakers and installing a larger breaker with more adequate capacity intended to operate and protect all of the circuits. These subterfuges have sometimes not operated in the manner calculated or protected some of the lower capacity equipment.

There is one bright spot in the horizon, however, and that is the recent development of air breakers, which, outside of the danger of flash-over, are relatively safe.

As fire protection people, we have offered several suggestions for the protection of oil breakers where they are located in congested areas.

We have, first of all, suggested they be relocated where they will have more isolation, or where incombustible barriers or partitions can be erected to isolate the breakers. This isolation is more easily said than done and frequently involves very expensive changes that are probably not justified against the cost of replacing the entire switchgear. As a temporary cure, we have suggested the area be flooded with carbon dioxide or water spray intended to quench fire in this highly vulnerable and critical area, before it has the opportunity to destroy the control wiring and instruments nearby.

We have recommended the taping of conductors using asbestos tape, and sylicate of soda, or using one of the incombustible plastic compounds recently developed to make the material in the vicinity of the switchgear less combustible.

In the past fifty years or more, it has been the practice of operating engineers to remove automatic sprinklers from over electrical equipment even under combustible construction in order to prevent damage to the electrical equipment. We are beginning to believe, and have considerable evidence to show, that this is not the right attitude. We have had many fires involving electrical equipment where the automatic sprinklers, although wetting the equipment, prevented a more serious damage. On the other hand, we have had fires in incombustible areas, where sprinklers were omitted where the damage would have been much less if automatic sprinklers had operated and controlled the fire, even withstanding the possibility of wetting down the equipment. The main fear, of course, was that of a sprinkler operating where there was no fire, but I think the law of averages indicates that this probability is so remote that it can be discounted.

Probably one of the best ways of indicating the probability of a sprinkler head operating, as we say—prematurely—that is without a fire, is a statement of the sprinkler leakage insurance rates, which after all, are supposed to be the actuarial of experience. The insurance rate for sprinkler leakage is one mil for a hundred dollars worth. Now, that is what we think about sprinkler leakage. That is what we think of the probability of a sprinkler head going off when there is no fire. We

will bet one mil against $100 that you will not have one mil's damage of sprinkler leakage in a year. That is pretty fair odds, and I think it probably expresses to you the probability of a sprinkler head operating.

A fire over some very elaborate and special equipment in the high voltage class of one of our large manufacturers in Ohio caused such extensive damage and resulted in the fire department throwing in heavy hose streams to the extent that this concern have now made it a standard requirement that automatic sprinklers be installed over all of their oil filled electrical equipment through their properties. This is a large concern that has properties in almost all of our 48 states. They have a very elaborate electrical department with some outstanding electrical engineers at the head of it. This is just a recent condition and it was quite interesting that they should make such a broad statement and a practice.

I believe also that you should give the subject of automatic sprinkler protection over oil filled electrical equipment serious thought before you decide to eliminate or shield off this valuable protection.

The need for protection of generators in industrial plants cannot accurately be measured on the basis that this protection is applied to utility properties. The electrical protection of generators in utility properties generally is only complete when the size of the generator has a material effect on the load being carried by the station or network. The most serious danger to a utility company is, that they will be unable to carry their peak load through the failure of one or more generators. Until this danger is paramount, the protection of smaller generating units does not appear to be important.

In other words, we are frequently asked to compare the electrical protection on generators in industrial plants to that which is the practice in utility plants. The utility plant is only interested in supplying its customers with uninterrupted service. They do that at the expense of all equipment, and when a generator is so large that it will cut a material factor in the output of that plant, then they begin to think about putting on full electrical protection.

This is not the case with industrial electrical generator equipment. Usually the industrial plant does not have an excess of generating capacity and the loss of one machine, even though it may be a small one, will materially affect the production of the plant. Therefore, we cannot say that we will put, for instance, differential relays on all generators of 10,000-kw capacity and above, as we would probably say in the utility plant, because in an industrial plant a generator of 2500-kw may cause the plant to operate at only partial capacity or in some cases, a complete shut-down, until this machine can be rebuilt.

We are not going into the details of electrical protection for generating equipment because it is assumed most electrical men are fully conversant with this problem. We are, however, confronted with the problem of protecting small machines. Sometimes the machines have been operating for a number of years, and the problem is to provide the electrical protection that probably has not been needed up to this time. Frequently, our problem is the protection of a number of small machines operating in parallel with other machines or outside power. With the machines delta-connected, the installation of differential relays is difficult, and the protection questionable. The best protection that can be applied in these cases is reverse current relays which are easily installed and afford the greatest percentage of protection.

That has been one of our problems in the past number of years to take these smaller built ungrounded machines that are now asked to operate in parallel with the public service company. The plant has outgrown the original generating system, and they now parallel them with the public service company. They operate that way without any individual machine protection. As you know, a differential relay is not of very much value on an ungrounded machine, and the danger of a failure in the machine or a fault occurring in the machine is quite severe, because the outside power would just burn the machine to a crisp before you could do anything about it. The reverse current relay does offer probably the greatest protection you can add to one of these old installations and get your money's worth of protection.

The actual extinguishment of fire in a generator is one that we hope to avoid. Naturally, the best protection is to prevent a fire from originating in the generator by putting on adequate and effective electrical protection. However, even with the best of electrical protection, there is occasionally a failure and a fire. With the newer totally enclosed generators, the extinguishing of fire in the machine is relatively simple and effective by the introduction of carbon dioxide into the cooling system. This can be introduced in any number of convenient locations as the volume of air is recirculated and the entire air capacity is made inert by the reduction of oxygen through the introduction of carbon dioxide. Usually one pound of carbon dioxide is supplied for each 22 cu ft of air volume space. Of course, one pound of carbon dioxide expands and occupies 8.7 cu ft of space at atmospheric pressure. Therefore, provision must also be made to release any excess pressure created. In the past, 32 sq in. of vent relief area have been provided for each 50-lb cylinder of carbon dioxide. This is probably excessive and more accurate calculations are now being compiled.

I am just bringing that to your attention because I have found that many concerns introduce or attach a cylinder or two of carbon dioxide to one of these self-contained cooling systems in the generator, and do not provide for the excess pressure that might be created. Of course, it may not be serious, but at the same time, it may cause the bursting or bulging of the ventilating system equipment. It may not leak out as fast as it goes in.

The releasing of carbon dioxide in enclosed generators is done in two ways, first, automatic and second, manually. The automatic release of carbon dioxide can most simply be done through the installation of thermal heat detectors in the windings of the machine, or in the air stream from the generator. This device is a simple bi-metallic hermetically sealed switch which closes, or opens, when the predetermined temperature is reached, depending if the release mechanism is designed on an open or closed circuit. There are other

methods of releasing carbon dioxide used, one of the most effective is probably through the operation of the differential relay when the machine is so protected.

In all carbon dioxide fire extinguishing systems there should also be a manual method of operating the system. This is frequently a trigger or pull box arranged where the operator can manually flood the machine with carbon dioxide if he feels this precaution is necessary.

In open generators the control of fire is not so simple. Here larger volumes of carbon dioxide must be used if an attempt is made to control a fire through the use of this material. The use of water spray is very frequently used in the protection of open machines or open ventilated machines where facilities for confining the gas in the generator is not adequate to produce effective extinguishment through carbon dioxide. In all cases where water is used in controlling a fire in a generator, we have recommended a manual arrangement, whereby a definite connection must be made in the water piping to the generator before water can be turned into this system. This is done to avoid leaking by closed valves or accidental operation. Obviously this is a slower method of extinguishment, but it has been found to be of great value. One of the more or less standard schemes that has been used is to provide a glass covered box or cabinet in the generator room in which water is supplied to a closed valve, a flexible hose connection unconnected and the piping connected to the generator. In order to put water into a generator, the operator must first break the glass in the cover of the box, make the manual connection between the flexible hose and the water supply pipe, and open the valve permitting the water to flow into the hose and into the piping to the water spray heads in the generator. Most of our larger generator manufacturers have designed a perforated water ring, for their larger machines at least, that fits inside of the end bell of the generator. These rings are so located that water coming from the perforations will strike the end of the coils and most effectively throw water into the area between the stator and the rotor.

There have been attempts to develop dry powder extinguishers for the control of the fires in electrical rotating equipment. This type of equipment has, as yet, not been proved too effective, as there is little heat quenching value to the dry powder, and the amount of heat usually generated is not sufficient to decompose the bicarbonate of soda content of the powder and develop sufficient carbon dioxide to promptly extinguish the fire.

In several cases where a dry powder has been used in rotating equipment, the dry powder has found its way into the air passages and the areas around the winding to such an extent that reconditioning of the equipment was quite difficult. All the windings had to be taken out, and the air passages carefully cleaned so a good ventilated machine could be restored. We have not found that dry powder is the best extinguisher for electrical rotating machines.

In addition to the use of installed fire extinguishing systems in rotating electrical equipment, we usually recommend the installation of at least 1½ in. rubber-lined hose in the generator room with a water spray or fog nozzle attached. We do not recommend that a combination of straight stream and fog nozzle be used in these installations, as there is danger of the operator accidentally turning on a solid stream and causing unnecessary damage. You may feel that we are somewhat promiscuous in the use of water around electrical equipment, but our experience has shown that in practically all electrical fires of major proportions, that water has been resorted to before the fire has been controlled. In some cases, the omission of permanently installed water protection in large enclosed machines has required that time be lost in the extinguishment of a fire until a welder could be obtained and cut holes into the generator enclosure sufficient to insert a hose stream. In that case, ironically enough, one of the recent ones was of our larger electrical manufacturers on their test floor where they had a large machine they were building for one of the public utility companies. It broke down under test, and they had to go to the welding shop and get a welder to cut a large hole in the casing so they could get a hose stream in and throw water on the fire. Here is a location on the test floor where they expect trouble, and where they have an abundance of ordinary fire extinguishers and equipment, but to have the extinguisher on the outside of a fully enclosed generator is rather hopeless.

There is a new thought which probably will bear considerable investigation and consideration in the automatic protection of totally enclosed electrical equipment, and that is the use of the photo-electric smoke detector in the ventilating system to actuate carbon dioxide automatically in the event that the air stream becomes contaminated with smoke. This method of actuating a fire alarm and a fire extinguishing system is being used today in many fields where fire damage is important to critical materials such as fur storage, warehousing or marine work, and it is only natural that eventually this method of detecting an irregular operation of a valuable generator will be resorted to.

The protection of valuable mill motors such as are found in our steel mills today offers a problem similar to that of protecting open generators. Generally, these motors are not enclosed and present a large area of combustible materials that might cause a very serious fire. It has been said that a clean motor never burns. This may be true of smaller capacity motors in that there is little in a modern motor using Class "B" windings to sustain combustion, if the dirt, lint and oil is kept out. The trend toward the use of totally enclosed motors in most industries is assisting to this end, that outside dirts are usually excluded.

There is little that can be offered for the protection of large steel mill type motors than to provide the 1½ in. rubber-lined fire hose equipped with a water spray nozzle within the reach of all these larger motors, so that when the motor has been taken off the line and the current surely disconnected, that there will be adequate extinguishing media available to completely extinguish the fire in the large surface area presented by these large motors.

Again the use of water must be accepted as inevitable and not completely disastrous in the control of a large mill motor. There have been many instances

where thoroughly wet down motors have been completely dried out and renovated so their life was not materially affected by the incident.

I can refer to the flood that occurred in Pittsburgh several years ago, where many generators and motors were under water, and dirty water, too, for several days. Most of them were rehabilitated and put back into service without serious loss.

On the other hand, if a fire in a mill motor is not quickly and effectively controlled, there surely will be complete destruction of the machine. Therefore, it is a choice that you have, under the circumstances, to decide whether you are going to throw water onto this equipment and go through the salvaging operations, or allow it to completely burn up and rebuild it completely or replace it with new.

DISCUSSION

PRESENTED BY

ROBERT W. HOLMAN, Assistant Works Chief Engineer, Gary Sheet and Tin Mill, Carnegie-Illinois Steel Corp., Gary, Ind.

R. J. BEESWY, Assistant Superintendent, Electric Power and Electrical Dept., Inland Steel Co., East Chicago, Ind.

L. A. TERRY, Superintendent, Power and Electrical Dept., National Tube Co., Gary, Ind.

KARL J. DOLL, Superintendent of Pittsburgh Service Shops, General Electric Co., Pittsburgh, Pa.

J. T. W. BABCOCK, Assistant Chief Engineer, Factory Insurance Association, Chicago, Ill.

Robert W. Holman: There is no more helpless feeling in the world than having a transformer about 15 to 18 feet high on fire, and there is nothing you can do until the fire department arrives. We actually did experience a case where a main drive motor was so tightly enclosed we could not use a carbon dioxide extinguisher until we removed some bolts and covers. I agree with the speaker the providing of fire protective equipment is not enough. In addition, it must be arranged so it is easily and effectively applied.

R. J. Beeswy: I believe Mr. Babcock stated he pipes water to enclosed generators, I would like to ask why he does not use steam? At Inland we have steam piped to all of our enclosed turbo-generators, with two valves in series, and a drain valve in between to eliminate the possibility of getting moisture in the machine.

J. T. W. Babcock: Steam has been used in the years past, but I think that there has been some danger of damaging or softening the insulation by the use of steam. Steam in itself is only water, and is only as good a fire extinguishing media as the water value of its content. Steam is water expanded 1700 times, and it does, in a fashion, exclude oxygen. Water spray also excludes oxygen, but in addition to excluding oxygen you have to cool the temperature of your burning material, and therefore it has been the consensus of most authorities that the quickest way to extinguish a fire is to put in the concentrated cooling agent, which is water.

L. A. Terry: We are using grit blasting for dry cleaning equipment. We, too, have had very good success with it and believe it is the best known method. The blasting removes dirt, oil, and polishes the insulation surfaces. It also removes dried, curled paint particles so that new paint is not put back on loose or blistered insulation. Use has been made of the machine for cleaning mechanical equipment, such as charging machines, hydraulic units, air compressors, etc., which were well plastered with oil and mill dirt. The grit falling on the floor is an excellent "oil dry," and when swept up removes the oil and grease from the floor area. Caution must be exercised in cleaning old oil soaked windings. If too high a pressure is used, it will cut through the insulation and damage the windings.

Karl J. Doll: Would the author make a comparison between a straight sprinkler outlet and a water fog nozzle? Would he make a comparisoon between the effectiveness of sprinklers versus water fog nozzles?

J. T. W. Babcock: You are splitting pretty fine hairs. Usually, a sprinkler head gives a water spray, or a fog when it is operating at relatively high pressures (60 psi or more). There are several types of nozzles that have been applied to water discharge in the last ten or fifteen years. They first came out with a low velocity water fog which was supposed to resemble very fine particles of water that are partially suspended in the air. Then they found that certain air currents affected the distribution of this water spray. Particularly when there was a fire, there were thermal updrafts that misdirected this fine water fog, to the end that they decided they had to have a higher pressure or a more directed water spray, and they came out with a water spray which is supposed to be slightly heavier, or larger particles of water with a little more force, so they would offset the thermal updraft or the wind.

The general idea of the whole picture is the theory that water particles are broken up into a fine mist and are more efficient in cooling than a larger particle; that the cooling is in proportion to the extent of its surface area. That theory can be projected down the line to the discharge of water from a sprinkler head at high pressures. You have the impact or water on the deflector on the sprinkler head that breaks up the water particles into a pretty fine mist, and if you have observed a sprinkler head operating under high pressure, you will find there is a considerable fog in addition to the heavier drops of water. Of course, when your pressures drop to below 40 or 50 psi, you begin to get heavier drops of water and less of the fine spray or fog.

The general idea of water spray, as we now think of applying the general term to all of these finer applications of water, is that you will get a more even distribution pattern of finer water particles over a wider range, so that you will get an efficient cooling with less run-off or less excess water. The sprinkler head still is a rather crude implement in that it discharges a large amount of water for all purposes, whether the application is necessary or not. In the refinement of fire protection equipment, we have found that larger quantities of water are necessary in some cases, but smaller quantities of water, more efficiently applied, will do the job just as well and probably quicker with less resultant water damage.

CURRENT AISE DISTRICT SECTION MEETINGS

BIRMINGHAM SECTION

Monday, February 26, 1951 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"Steel Mill Lubrication" by W. H. Mandy, The Texas Co.

Thomas Jefferson Hotel, Birmingham, Ala.

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BUFFALO SECTION

Tuesday, February 13, 1951 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"Electronic Applications in the Steel Industry" by A. Black, Chief Electrical and Experimental Engineer, Steel and Tube Division, Republic Steel Corp., Cleveland, Ohio.

Sheraton Hotel, 715 Delaware Ave., Buffalo, N. Y.

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CHICAGO SECTION

Tuesday, February 6, 1951 — Dinner 6:15 P.M.; Meeting 7:45 P.M.

"The Chemical Removal of Deposits from Steel Plant Equipment" by B. H. McDaniel, Dowell, Inc.

Phil Smidt's Restaurant, 1205 North Calumet Ave., Hammond, Ind.

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CLEVELAND SECTION

Monday, February 19, 1951 at Cleveland, Ohio — Dinner 6:30 P.M.; Meeting 8:00 P.M.

Tuesday, February 20, 1951 at Youngstown, Ohio — Dinner 6:30 P.M.; Meeting 8:00 P.M.

"A New Arc Quenching Principle in Industrial Control" by O. M. Bundy, Assistant Chief Engineer, Clark Controller Co., Cleveland, Ohio.

Cleveland: Cleveland Engineering Society, 2136 E. 19th St., Cleveland, Ohio.

Youngstown: El Rio Club, Youngstown-Warren Rd., Route 422, Youngstown, Ohio.

DETROIT SECTION

Tuesday, February 13, 1951 — Dinner 6:30 P.M.; Meeting 8:00 P.M.

'Operating Practice and Problems on High Speed Tandem Mills and Survey of Economics of High Speed Cold Mills" by Fred K. Schefe, Flat Products Engineer, United States Steel Co., Pittsburgh, Pa.

Horace Rackham Educational Memorial, Detroit, Mich.

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PHILADELPHIA SECTION

Saturday, February 3, 1951 — Dinner 6:00 P.M.; Meeting 7:00 P.M.

"Heating of Steel Mill Buildings" by George J. Campbell, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

"Maintenance of Building Structures" by R. O. Chapman, Field Foreman, Bethlehem Steel Co., General Mechanical Department, Sparrows Point, Md.

"General Ventilation of Steel Mill Buildings" by Wm. S. Johnson, Plant Industrial Hygienist, Bethlehem Steel Co., Bethlehem, Pa.

"Recent Developments for Steel Mill Lighting" by Davis H. Tuck, Chief Electrical Engineer, Holophane Co., Inc., New York, N. Y.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

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PITTSBURGH SECTION

Monday, February 19, 1951 — Dinner 7:00 P.M.; Meeting 8:00 P.M.

"Application of Electronic Control" by W. R. Harris, Manager Metal Working Section, Industry Engineering Department, Westinghouse Electric Corp., Pittsburgh, Pa.

"Designing Electronic Equipment Details for Minimum Maintenance" by Clyde F. Giegel, Service Engineer, Pittsburgh District, Reliance Electric and Engineering Co., Pittsburgh, Pa.

"Equipment for Electronic Maintenance Shop" by H. L. Palmer, Control Engineering Divisions, General Electric Co., Schenectady, N. Y.

"Maintenance of Electronic Equipment in the Steel Plant" by O. P. Robinson, District Manager, Cutler-Hammer, Inc., Pittsburgh, Pa.

University Club, University Place, Pittsburgh, Pa.

John F. Black

PRESIDENT, 1951

ASSOCIATION OF IRON AND STEEL ENGINEERS

JOHN F. BLACK received his elementary schooling in the Enid, Okla., city schools and attended the United States Naval Academy, class of 1926. He started in the steel business as pipefitter helper at Bethlehem Steel Co.'s Sparrows Point plant, progressing to steel shipper, labor foreman, gashouse foreman, general foreman of gas producers, combustion engineer, and general foreman of pipe mills. In 1941 he transferred to Atlas Steels, Limited, Welland, Ontario, as fuel engineer, and in 1943 was made assistant works manager. In January 1947, Mr. Black was appointed general superintendent, Buffalo plant, Wickwire Spencer Steel division of the Colorado Fuel and Iron Corp. In December 1949, Mr. Black went to work for the Youngstown Sheet and Tube Co. as assistant general superintendent, Indiana Harbor.

The President's Message

Events of recent months indicate little reason for expecting tranquility in the immediate future. The watchword on the economic front must be preparedness, and this calls for thoughtful and intelligent planning. Our future safety and economy may depend on how well we plan and prepare.

The Association of Iron and Steel Engineers will serve, as always, as an important medium for the exchange of technical and operational know-how for the industry. With our combined energies concentrated on better techniques and greater production, we will successfully meet the challenge of the present and safeguard our future.

J. F. Black

President, AISE

I. N. TULL
First Vice President

JOHN L. YOUNG
Second Vice President

E. L. ANDERSON
Treasurer

NEWLY ELECTED OFFICERS AND DIRECTORS

I. N. TULL was born in Anniston, Ala., reared in N. C., and graduated from North Carolina State College in electrical engineering in 1910. After a brief period of telephone work, he entered General Electric Co.'s test course at Schenectady. He was transferred to their Cleveland office's engineering department in 1912, remaining there until 1915, when he was employed by Corrigan, McKinney and Co. as electrical engineer. The next 12 years were spent in engineering and construction work as that company built blast furnaces and a steel plant at Cleveland, Ohio and proceeded with extensive electrification of their iron mines and the opening of coal mines. In 1927, general supervision of electrical maintenance and operations was added to the construction duties. After the merger with Republic Steel Corp. in 1935, Mr. Tull became electrical superintendent of the Cleveland district for Republic.

JOHN L. YOUNG is a native of Evansville, Ind. and graduated from the University of Indiana. Mr. Young began his career with Timken Roller Bearing Co. in Canton, Ohio, where he held various positions in the alloy tube and steel departments; he later transferred to the metallurgical department. In 1930, Mr. Young went to Pittsburgh for Timken as a development engineer, and later returned to Canton and became assistant general manager of Timken's industrial division. Mr. Young joined United Engineering and Foundry Co., Pittsburgh, Pa., in 1936. In 1941, he was loaned as project manager to design and construct the Defense Plant Corp.'s aluminum rolling mills at Trentwood, Wash. He was next vice president in charge of industrial research and development for United Engineering and Foundry Co. He then moved to National Tube Co. in 1945 as vice president in charge of engineering. On January 1, 1951, he became vice president—engineering of the United States Steel Co. in Pittsburgh.

E. L. ANDERSON has been associated with the iron and steel industry for over 30 years, having started in the electrical department of the Bethlehem Steel Co. at Sparrows Point, Md., in 1917. He was transferred to the Johnstown plant of Bethlehem in 1937, and was appointed superintendent of the electrical department of that plant in 1940.

J. H. VOHR was graduated from Cornell University in mechanical and electrical engineering in 1916 and became associated with the New York State Railways as an electrical engineer. After serving in World War I, he joined the American Sheet and Tin Plate Co. at Farrell, Pa., and later was transferred as assistant superintendent of strip mills to the company's plant at Gary. After leaving the company in 1931, he was engaged with the installation and operation of the wide strip mills of the Inland Steel Co. and Youngstown Sheet and Tube Co. In 1936 he joined the Granite City Steel Co., Granite City, Ill. as superintendent of the hot and cold strip mills and was promoted in 1937 to general superintendent of plants. In 1942 he transferred to the Carnegie-Illinois Steel Corp., being stationed at the general offices in Pittsburgh until his appointment in 1943 as assistant general superintendent of South Works of Chicago, Ill. In 1949, he was promoted to the general superintendency of Gary, Ind. steel works.

W. H. COLLISON was graduated from the University of Cincinnati in 1926 with a degree of chemical engineer. This was a cooperative course during which he worked in the coke plant of Pittsburgh Crucible Steel Co., beginning in 1924 and continuing after graduation until 1927. He then went to the Central Alloy Steel Corp., Massillon, Ohio, as heater in the coke plant, and was made turn foreman shortly thereafter. In 1935, Mr. Collison went with the Pure Oil Co., Marcus Hook, Pa., as a chemist. Following this he came to Detroit as boss heater for the new coke plant of Great Lakes Steel Corp., being subsequently promoted to assistant superintendent and later to superintendent of the coke plant.

C. W. BRUCE was graduated from Case Institute of Technology in mechanical engineering in 1933. He started in the steel business in the blooming mill at the Corrigan-McKinney Steel Co., and in 1934 transferred to the combustion department. After the merger with Republic Steel Corp. in 1935 he continued in the combustion department until 1942, at which time he was transferred to the Chicago district of Republic Steel Corp. as combustion engineer. In 1947 he was made assistant chief engineer of the Chicago district.

JOHN H. VOHR
Secretary

W. H. COLLISON
Director-at-Large

C. W. BRUCE
Director

C. E. DUFFY
Director

J. H. FRANZ
Director

W. E. HART
Director

ASSOCIATION OF IRON AND STEEL ENGINEERS 1951

C. E. DUFFY was born in Baldwinsville, N. Y., and after completing high school attended Clarksons College of Technology where he received a B.S. in Mechanical Engineering. In June 1926, he entered the Bethlehem Steel Corp.'s Loop Training Course at Bethlehem, Pa. and in September of the same year was transferred to the fuel department of Bethlehem's Sparrows Point Plant to assume the duties of testman. He became the assistant fuel engineer of the fuel department in 1930, and fuel engineer in 1948.

J. H. FRANZ was born July 10, 1910 in Glenshaw, Pa. and attended Shaler Township, Pa., schools from 1916 to 1926. He graduated from Etna, Pa., high school in 1928, and began to work in April of 1929 for Carnegie Steel Co. as an electrician's helper. From 1929 to 1937, he held various maintenance department jobs, such as electrician's helper, welder, electrical millwright, etc.

He entered Carnegie Institute of Technology night school in 1931 and received a certificate of electrical engineering in 1937, then received a bachelor of science degree in electrical engineering in 1941. In June 1937, he was transferred to the Edgar Thomson works, engineering department as assistant electrical engineer, and in July 1941, was transferred to Carnegie-Illinois Steel Corp. ordnance engineering bureau as chief electrical engineer. He transferred to Youngstown district of Carnegie-Illinois as chief electrical engineer in May 1943. In March 1946, he was made assistant to division superintendent of maintenance of Youngstown district, Carnegie-Illinois.

He was promoted in July 1948 to superintendent of operating maintenance department, Ohio works of Carnegie-Illinois Steel Corp. Since May 1949 he has been superintendent of the fabricating shops of the McDonald mills, Carnegie-Illinois Steel Corp.

WARREN E. HART, a native of Detroit, Mich. and long associated with the Ford Motor Co., Rouge plant, accepted his present position as superintendent of the electric furnace building early in the year of 1935. His metallurgical experience has been entirely with the Ford Motor Co.'s foundries, and ingot steel operations. His technical education was obtained through various Michigan Educational Institutions, including the Henry Ford trade school.

WADE F. HOFFMAN was born in Vandergrift, Pa. He attended public schools there and at Peddie Institute, Hightstown, N. J. Mr. Hoffman graduated from Bucknell University at Lewisburg, Pa. with a degree of Bachelor of Science in Civil Engineering in the Class of 1922. He attended a special course at Carnegie Institute of Technology. Upon graduating from school, he was employed as a draftsman in the engineering department of the Vandergrift plant of the Carnegie-Illinois Steel Corp. until October 1925, then was employed as a draftsman in the Aliquippa Work's engineering department of the Jones & Laughlin Steel Corp. In April 1929, he was transferred to the roll shops and in April 1936 was appointed assistant superintendent, and in May 1945, superintendent of the Aliquippa Works roll shops, which position he now holds.

J. WALTER JOHNSON was born in Chicago, Ill., and a few years later moved to Birmingham, Ala., where he attended public schools, Ensley high school and Auburn University. He was employed by Tennessee Coal, Iron & Railroad Co., Ensley and Fairfield works, as a levelman progressing to construction engineer. In 1935 he was transferred to the Ensley works rail mill as turn foreman, where he became night superintendent of rail mill. He is now assistant superintendent of the bessemer rolling mills, Birmingham.

HARRY H. NORTHRUP was born in Centre County, Pa. and is a graduate of the Pennsylvania State College with the degree of bachelor of science in metallurgy. He joined the Republic Steel Corp. in Youngstown, Ohio in 1935 and worked successively as third, second and first helper and melter in that open hearth department. He transferred to the Buffalo plant of the same company as assistant open hearth superintendent in 1942. He was made superintendent of open hearth of the Buffalo district in 1947.

WADE F. HOFFMAN
Director

J. W. JOHNSON
Director

H. H. NORTHRUP
Director

S. C. READ
Director

F. E. ROBINSON
Director

V. E. SCHLOSSBERG
Director

S. C. READ attended Purdue University and the University of Michigan, graduating from the latter with a degree in mechanical engineering. He later received a master's degree in metallurgical engineering at Carnegie Institute of Technology. Mr. Read started to work for Jones & Laughlin Steel Corp., Pittsburgh, Pa., in 1924 as assistant superintendent, power department at the South Side works. In 1938 he was made master mechanic of rolling mills, Pittsburgh works. He was appointed superintendent of blooming department and rolling mills, Pittsburgh works in March 1946. In November 1947 he was named manager of maintenance for the entire corporation. Mr. Read has since been made a director, construction and maintenance.

FRANK E. ROBINSON was born in Lima, Ohio and a few years later moved to Birmingham, Alabama, where he attended public schools and technical high school. During the first world war he was employed by Tennessee Coal, Iron & Railroad Co. as a draftsman on the construction of the first units of Fairfield works. In 1920 he came to Cleveland with Otis Steel Co. as chief draftsman in the blast furnace division, and completed a night school course in mechanical engineering at John Huntington Polytechnic Institute. In 1925 he began working for American Steel & Wire Co. as designer-checker, later being advanced to section head draftsman, assistant construction engineer and in 1945 to a newly created position of division engineer of projects. At the present time he is assistant division engineer.

V. E. SCHLOSSBERG graduated in 1926 from the Rose Polytechnic Institute and immediately went to work for the Inland Steel Co. He started as laborer in the rail mill, rose to assistant superintendent of the electrical department in 1930, and superintendent of the electrical and power departments in 1946. In 1950 he was appointed assistant chief engineer of the Indiana Harbor Works of Inland Steel Co., the position which he now holds. In 1945 he spent several months in Germany as a member of the technical group sent there to investigate the German steel industry.

R. R. THOMAS is the assistant chief engineer, blast furnaces and steel works, Tennessee Coal, Iron and Railroad Co., Birmingham, Ala. Mr. Thomas began his career with the United States Steel Corp. subsidiary in 1907 as a blueprint boy at the Ensley Works. He became chief draftsman of the open hearth division in 1926 and was made assistant chief engineer of blast furnaces and steel works in 1929.

DONALD E. WHITEHEAD attended Culver Military Academy and the Carnegie Institute of Technology. He worked in lubricant sales for the Sun Oil Co., Pure Oil Co., Gulf Oil Corp., and Tide Water Associated Oil Co., Inc. He then went to work at the Homestead Works of Carnegie-Illinois Steel Corp. as lubrication engineer and was then advanced to general lubrication engineer of the entire Carnegie-Illinois Steel Corp. He is now general lubrication engineer, Crucible Steel Co. of America, Pittsburgh, Pa. Mr. Whitehead is a registered mechanical engineer in the state of Pa.

W. E. ZELLEY was born at Fieldsboro, N. J. on November 4, 1901, and after completing his high school studies was employed by the Public Service Electric and Gas Co. at their generating station at Burlington, N. J. He studied electrical engineering at the School of Industrial Arts, Trenton, N. J., graduating in 1923. Mr. Zelley was employed by John A. Roebling's Sons Co., June 1923, as an electrician, advancing to the position of assistant general foreman of the electrical departments by September 1933. He was appointed general foreman of electrical departments in June 1940 and advanced to the position of staff engineer, electrical, August 1945, holding that position until January 1947, at which time he was appointed superintendent of maintenance, construction, and utilities at the Roebling, N. J. plant.

R. R. THOMAS
Director

D. E. WHITEHEAD
Director

W. E. ZELLEY
Director

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Developments

IN THE IRON AND STEEL INDUSTRY

During 1950

By I. E. MADSEN

▲ THE year 1949 opened with the industry trying to catch up on the backlog left as a result of the steel strike in the latter part of 1949. When it appeared that the steel industry had caught up with demand, the Korean crisis arose, and since then the efforts of the operators have been to produce more and more, to keep their facilities operating at full capacity and to minimize shutdowns for maintenance as much as possible.

All records for steel production were broken in 1950. Total production was about 96,900,000 tons or 96.4 per cent of capacity, compared with almost 78,000,000 tons last year. Of this, estimated figures give a production of about 86,400,000 tons for the open hearth, 4,500,000 tons for bessemer, and 6,000,000 tons in the electric furnace. Total pig iron production for 1950 was estimated at 66,100,000 tons or 92.2 per cent of capacity compared with 54,175,534 tons, one year ago.

Expansion Estimates — Against a background of high demand for steel has been the clamor on the part of steel users and the government that the steel industry expand. The outstanding development of the year is that the industry is now embarked on an expansion program which will increase capacity as much and as fast as it is possible to do so. This expansion program is developing and increasing so fast that as soon as one program is announced it is already obsolete, as capacities of proposed facilities are increased even before actual work on announced expansion programs is started. The new expansion program will be at a much faster rate than the present program under which the industry has invested $2,400,000,000 since the end of the war, which is somewhat more than their aggregate net income for the period. At the beginning of 1950 the capacity of the steel industry was 99,392,800 net tons of which 86,984,490 tons were open hearth, 5,537,000 tons were bessemer and 6,871,310 net tons were electric capacity. On July 1 as new facilities went into production, the capacity of the industry was officially rated at 100,563,500 tons with 87,858,990 open hearth, 5,621,000 bessemer and 7,083,510 tons electric. A total 1216 open hearths and 248 blast furnaces (71,622,000 tons) were in production when the Korean war started.

The ingot capacity at the end of 1950 totaled about 101,537,800 tons which is a gain of about 2,145,000 tons since the end of 1949. About 1,500,000 tons of this new capacity came through enlargement and modernization of existing facilities. Open hearth capacity gained about 1,900,000 tons and electric furnace capacity expanded 222,000 tons.

At the middle of the year planned expansion of the industry would have raised it to 105,750,000 ingot tons by the end of 1952. Less than two months later, announced planned steel capacity was up to 109,963,000 net ingot tons, and in addition, blast furnace capacity was to be increased 1,734,000 tons to a total of 73,378,000 tons by the end of 1952.

The latest plans for steel expansion will give capacity of about 120,000,000 tons by the end of 1954. Such capacity requires large and important auxiliary facilities, additional sources of raw materials and additional carriers to move the materials to the steel plant. Since new steel capacity costs about $300 a ton, additional facilities built will eventually increase steel prices in order to write off the higher capital costs over those of present facilities. At the Congressional Committee on Economic Report investigation, C. B. Randall, president, Inland Steel stated that a blast furnace which would cost $10,800,000 in 1949 will cost $21,700,000 today. Without proper price and profit incentives, capital is extremely difficult to raise for proposed expansions.

Earle C. Smith of Republic Steel gave an estimate in which he predicted that the steel industry would reach an ingot capacity figure of 125,000,000 tons by 1970. His rate of growth is somewhat slower than some of the other estimates because he feels that iron ore supplies cannot keep pace with expansion until 1957, when ore imports will catch up with ore needs.

The expansion of the steel industry also requires expansion in coke making facilities. An additional ton of coke-making capacity is required for every additional ton of annual ironmaking capacity. In addition to the present oven replacement and rebuilding program, an additional 400 new by-product ovens with a capacity of 2,240,000 net tons have been contracted for.

In 1950 steel companies scheduled for completion 562 new coke ovens with an annual capacity of 3,274,000 tons. An additional 210 more ovens with over 1,000,000 tons of capacity is projected for 1951, and at least 100 more will be completed in 1952 according to presently approved plans. Total coke capacity at the end of 1950 was 68,700,000 tons.

One of the factors which may accelerate some steel plant expansion is the threat by the government that

it will build or finance plants in competition with privately owned industry. The capacity target advocated by assistant secretary of the Interior, C. Gerard Davidson, is about 130,000,000 tons a year.

Not all of the criticisms of the steel industry came from Washington. One also came from C. E. Wilson, president of General Motors, who compared steel plant expansion with automobile expansion, an unfavorable comparison for steel. However, there is the very practical factor here that an investor may prefer to invest his money in industries where he may get a better return rather than in the steel industry.

There are some who state that, in the expansion of steel capacity, consideration should be given to building small plants for local markets. It is claimed that this offers an economical solution to the problem of increasing freight rates. Such plants would have annual capacity of about 100,000 tons, and it is claimed they can be built for about $5,000,000. Such plants may consist of electric and fast continuous mills for making bar and flat rolled products. Basic requirements are a good market and scrap at the right price. Areas such as Boston, New York and Central Michigan might well support such mills.

Examples of this sort of operation are Connors Steel Co. and McLouth Steel. This latter plant has an annual capacity of about 400,000 tons and cost about $25,000,000. This plant, which depends on electric furnace steel, gets 80-ton heats from its furnaces, rolls 26 × 44-in. ingots into slabs as thin as 5/8 in. in the blooming mill, which then go directly into a reversing hot strip mill.

One factor which will affect the location of steel plants was a reduction in railroad rates from Baltimore and Philadelphia to Pittsburgh, Wheeling, Youngstown and Cleveland. Reductions range from 28 to 68¢ a gross ton. This is in anticipation of ore imports which will result from the new developments in Venezuela and Canada, and also is an important factor in the consideration of new east coast steel plants.

At the end of the year, the railroads asked for a 4 per cent freight rate increase and this will add about 25 to 40¢ to the cost of finished steel.

The truck industry on the other hand revised some of their rates, resulting in increases of about 10 to 20 per cent on 20,000 lb lots, and applying existing 20,000 lb minimum rates to lots of 32,000 lb or more.

One interesting item in the freight picture are operations such as that of Sharon Steel, who runs its own trucking service. In addition to hauling finished products, the trucks also return with loads of raw materials such as scrap.

In the expansion of the steel industry, the Chicago district should grow faster than the average, for although this area's consumption is 45 per cent of total national consumption, it produces only about 25 per cent of the total. The western Pennsylvania-Ohio area which has 50 per cent of steel productive capacity and only 25 per cent of national consumption, will lose particularly since the Chicago district's proximity to raw materials should help accelerate this trend.

In the Chicago area, steel plants are considering shiping in their coal by barge on inland waterways. This would give year-around movement with rates lower than rail rates.

All-rail shipments of iron ore, however, because of capacity operations and the short shipping season, caused some concerns additional costs of about $1.50 a ton more than the normal boat-rail shipment.

Prices — The controversial f.o.b. bill died a natural death during the year as President Truman vetoed the O'Mahoney freight absorption bill. Mr. Truman stated that there is nothing wrong now with absorbing freight or with quoting delivered prices. The only criteria is that there should be no collusion or concerted action on the part of the steel industry. How present laws would be interpreted in the courts is enough to give most steel officials gray hairs. As part of this program the American Iron and Steel Institute canceled its railroad freight tariff book.

At the beginning of the year, the price increases which came as a result of pension plans which were set up with the unions at the end of 1949 created a flurry of excitement. As a result, a congressional committee, the Joint Committee on the Economic Report, after prolonged investigation issued a report which called for systematic studies by the FTC of prices, costs and profits, a requirement that steel companies notify FTC of contemplated price increases and several other factors. With the beginning of the war and with the resultant desire to expand capacity, these requirements fell by the wayside.

The demand for steel put the gray market back into business by the end of the year, and prices of some sheet products went as high as $700 a ton.

Prices quoted by the steel producers also rose slightly during the year because of advances in the factors which make up the cost of steel, namely wages, raw materials and taxes. The fifth round of wage increases which went into effect on December 1 increased the average hourly rate 16¢. As a result prices went up $5.50 a ton.

As a result of the rises in the cost of steel, the composite average at the end of the year was given as 4.131¢ per lb compared with 3.836¢ per lb at the beginning of the year. This price includes other raises announced during the year which are in addition to the one which accompanied the fifth round of wage increases. The average composite price for basic pig iron at the end of 1950 as given by another source was $52.04 a ton compared with $45.60 a ton a year ago.

The proposed tax legislation before Congress, whether in the form of an excess profits or in the form of a higher corporate tax, will also undoubtedly increase steelmaking costs. For example, in 1949 the tax per ton of steel for United States Steel Corp. was $10.01 compared with $4.47 in 1939. Total tax bill for the majority of the industry in 1949 was $490,000,000 which includes Federal, State and local government taxes. It was equivalent to $0.19 for each $1 paid in wages and salaries. One favorable factor in the tax structure is the five year depreciation allowance which will be allowed for emergency facilities. This is a boon to plant expansion. The accelerated depreciation which is now being allowed by the United States government for defense expansion does not necessarily mean that all the cost can be charged off in five years. In the case of Jones & Laughlin, the first steel company to receive approval, their write-offs on eight certificates ranged from 35 to 80 per cent with an average of 55 per cent

Knowledge of the mechanism of steel hardening was advanced considerably during the year in the work which was done in the metallurgical department of Massachusetts Institute of Technology.

for the $144,000,000 in their new expansion program.

One factor which is helping to keep steelmaking cost down is that less than one-half the manhours are required at the present time in the blast furnace and open hearth per ton of metal compared with thirty years ago. A major factor in this improvement is the modern equipment, although capacity operations also get in the picture. Manhours required per ton of steel in 1948 was 17.8 compared with 30.5 in 1934 and 19.2 in 1946.

Steel Allocations — As a result of the demand for steel it was necessary to put steel under the priority program which has been set up by the National Production Authority. The "DO" (Defense Order) was a new development which will become a very important factor in all steel plant purchases. This order which went into effect last October may progress into some sort of a controlled materials plan sometime this year.

No one can tell how much of the steel capacity will be governed by priority orders but preliminary estimates are from 2,000,000 to 3,000,000 tons a quarter or around 15 per cent. These percentages may build up heavily by the latter part of the year as the freight car and ore boat program get under way. A large proportion of this demand for priority products is in sheet, strip and plate, and the percentages in these products will be much higher.

The present freight car program involves over 100,000 cars which alone means 2,000,000 tons of steel. The ore boat program involves over 50,000 tons of steel for seven lake ore carriers, and this is only a portion of the program. The petroleum program is estimated to require 12,000,000 tons in 1951, which is 2,000,000 more than 1950. The automobile industry will probably take less material than the approximately 12,000,000 tons it took in 1950 as cutbacks in raw materials hold down production.

Shortages in raw materials and in alloys particularly is resulting in alloy steels being made on the lean side. The National Emergency steels will also undoubtedly become a much more important factor in production. Intensifiers such as boron will be more widely used.

Tin plate production is set for major expansion. It is expected that the 1950 capacity of 109,000,000 base boxes will be increased to about 123,000,000 by the end of 1951.

Plant Expansion — Following approval of tax writeoffs for Jones & Laughlin, accelerated depreciation writeoffs have been issued to about eighteen companies and these will provide about 5,500,000 tons of ingot, 2,500,000 tons of coke and 2,750,000 tons of pig iron annual capacity. With Jones & Laughlin program, total ingot capacity is about 7,000,000 tons. Among the companies in the program are Armco Steel and Sheffield Steel with about $165,000,000, Lone Star Steel Co. with about $73,000,000, Great Lakes Steel $43,000,000, Republic Steel Corp. with about $16,000,000 at Birmingham and Alabama City, Ala. and South Chicago, Ill., Northwest Steel and Wire with about $15,000,000, Empire Steel Corp. with about $10,000,000, and Weirton Steel with about $7,000,000. Included also is about $26,000,000 for an expansion program at Crucible Steel which will be used in the rebuilding and enlargement of eleven open hearth furnaces, four electric furnaces, a new blast furnace, and thirty coke ovens. The Youngstown Sheet and Tube Co. had an $86,000,000 expansion program at East Chicago approved. A number of smaller projects have also been approved.

Although expansion plans are far from complete, some of the trends are beginning to make themselves clear. The United States Steel Corp. is pushing a program which will increase annual capacity about 1,660,000 tons which will be available within the year. Expansion will take place at Gary, South works, Edgar Thomson, Duquesne, Clairton and Ohio works.

As an example of concentration of equipment, U. S. Steel Corp. now has 34 modern units at six locations in place of the 446 old fashioned sheet and tin mill units at 43 locations when it was first organized. At the present time however, it produces 4.5 times as much steel product.

The latest approved program of the United States Steel Co. plant at Morrisville, Pa. is that the unit will have a capacity of 1,800,000 ingot tons thus making it the largest single expansion project ever undertaken by any steel company. Estimated cost from NSRB certificate is about $351,000,000 plus $47,000,000 for a tube plant. The plant will be named the Fairless works and is scheduled for completion by the end of 1952. The plant will produce carbon and alloy ingots, blooms, slabs, bars, rods, squares, wire rod, light plate, pipe, hot and cold rolled sheet and strip, electrolytic and hot dipped tin plate. Facilities already authorized include 285 by-product coke-oven with an annual capacity of

916,000 tons of coke, two blast furnaces with an annual capacity of 1,200,000 tons of pig iron, nine open hearth furnaces with an annual capacity of 1,800,000 tons of steel, an 80-in. hot strip mill, a blooming and slabbing mill, a billet mill, a bar mill, a skelp mill, two Fretz-Moon continuous butt weld pipe mills.

In addition to the new United States Steel plant at Morrisville, Pa., the National Steel Corp. has purchased a 2200-acre site in New Jersey.

U. S. Steel Corp. is planning to add 500,000 tons of annual ingot capacity to the present 2,850,000 ton capacity of T.C.I.& R.R.Co.

Also on the United States Steel expansion program are additional cold reduced sheet and tin plate facilities at the Pittsburg, Calif. plant of Columbia Steel. In addition, new hot roll facilities are being installed at the Geneva Steel Co. plant for the production of an additional 100,000 tons. At the completion of these programs, sheet and tin plate products capacity of United States Steel Corp. on the West coast will be about 640,000 tons. The Kaiser Steel Corp. has also been expanding, thus adding to west coast facilities. Included in the present expansion are facilities for an annual production of 200,000 tons of hot dipped and electrolytic tin plate, and an additional open hearth. Present capacity of the plant is about 1,200,000 tons. The company has also filed a plan with the NSRB by which capacity of Fontana could be expanded an additional 700,000 ingot tons at a cost of about $400,000,000. Mr. Kaiser made the statement during the year that the United States should have an additional 30,000,000 tons of steel capacity as soon as it can be built.

The west will also get additional capacity in the expansion program announced by Colorado Fuel and Iron who are planning two new 225-ton open hearths and the rebuilding of a blast furnace, as well as the installation of a new 10-in. rod mill. This will increase steelmaking capacity 325,000 tons and iron capacity 45,000 tons.

At midyear, Bethlehem Steel Co. announced a $100,000,000 additional expansion program which will add additional sheet and strip facilities at Sparrows Point and Lackawanna. Also included is a modernization program at the Johnstown plant. The program at Sparrows Point will increase flat rolled capacity there about 900,000 tons a year. This includes a 68-in. cold mill and an additional stand on the present 58-in. cold mill. Ingots will come from Bethlehem and Steelton.

The Republic Steel Corp. is also starting a major expansion program in the Cleveland district. The expansion program includes a by-product coke plant of 126 coke ovens, a 1400-ton blast furnace (in addition they are acquiring ownership of the DPC No. 5 furnace), four 275-ton open hearths, a new 72-in. tandem cold reduction mill. In addition, auxiliary facilities and improvements and expansions will be made to existing equipment.

Republic Steel's expansion in Alabama consists of a 63-oven battery at Thomas, Ala., and two open hearth furnaces at Gadsden.

The Jones & Laughlin Steel Corp. has taken the initial step on a major program which will increase rated ingot capacity from 4,850,000 to 6,400,000 tons in the next year. This includes a total of six furnaces in addition to those now under construction at Pittsburgh, a new blooming mill and a new bar mill at this plant. As a result of this program the Pittsburgh works will roll all the steel at this plant on three hot mills, a 96-in. strip mill, and two bar mills instead of the 14 hot mills which were required during the middle thirties. This illustrates a trend to fewer and larger, although flexible mills. At Aliquippa, the new high speed cold reducing mill, installed in 1949, has turned into such a tonnage producer that an additional temper mill and electrolytic tinning line are being installed at this plant to make full use of the capacity of this mill. This also increases tin mill product capacity about 50 per cent. Two additional open hearths are being planned at the Otis works which will add 360,000 ton annual capacity, and a new larger blast furnace will replace the present 650 ton unit.

The Youngstown Sheet and Tube Co. is expanding and modernizing many of its facilities, and included in their program are four new open hearth furnaces at the Indiana Harbor works. When these furnaces are in operation, the company plans to discontinue its bessemer department capacity at Indiana Harbor. Final capacity will be about 4,500,000 tons. The extensive expansion program at Indiana Harbor also includes a 75-oven coke oven battery, a 28-ft hearth diameter blast furnace, two ore unloaders, and four more new 250-ton open hearths, in addition to the four furnaces now under construction. Eight 2-hole soaking pits, one slabbing mill and a hot strip mill. Various auxiliaries are included in this program which will also increase coke capacity 430,000 tons a year, iron capacity 500,000 tons a year and ingot capacity 1,225,000 tons a year.

Armco Steel is planning a $35,000,000 expansion at the East works in Middletown, Ohio, which will include a blast furnace, coke ovens and other replacement. A large electric furnace is being installed at the Houston plant of its subsidiary Sheffield Steel. Total present planned ingot capacity expansion is about 1,000,000 tons.

Sharon Steel is starting a $50,000,000 program which will raise its capacity about 560,000 tons to about

Powered either by a portable generator or ordinary 110/115 volt current, this improved electrostatic sampler is used to trap all types of dusts, fumes and smoke in atmosphere.

2,000,000 tons total. Included in this program is the enlargement of eight open hearths from 130 to 200 tons, an 850-ton blast furnace, new bessemer converter facilities, a coke and by-product plant and additional rolling mill facilities.

The Atlantic Steel Co. is planning to increase its steelmaking capacity 50 per cent as well as double its rolling capacity. Included in the program is a 60-ton electric furnace and a new bar mill.

There has been a great deal of discussion on the possible construction of a steel plant in New England. Under the present setup, none of the existing steel companies feel it desirable to take on such a plant. The general feeling has been that they would prefer to use their manpower and capital to expand their existing facilities. As a result, it appears that if such a plant is built it will be done with government help under the Defense Production Act. The war situation may thus result in the construction of the mill. The location will probably be in the New London, Conn. area, although this has not been determined. No details are available either on capacity or facilities but it would be constructed to meet the New England market if it is started.

One of the largest postwar steel plant expansions went into full production during the year. This was the modernization of the Lorain works of National Tube Co. This expansion program increased coke making capacity 800,000 tons, expanded pig iron capacity and included the latest in rolling mill facilities. One item in the program is a new bessemer steel plant with four 25-ton, all-welded bessemer converters, the first time that such units have been made completely welded. In use in this plant is special deoxidation process developed by the National Tube Co. which produces a better grade of steel particularly suitable for pipe production. Under this method molten blast furnace iron containing 4 per cent carbon is added to the vessel immediately after the converter blow subsides, the carbon silicon and manganese in the iron combine with the oxygen dissolved in the steel and forms CO gas which burns while the other oxides enter the slag.

Raw Materials — Most of the basic metal industries have decided to go ahead with major expansion programs. The aluminum industry, however, is getting government support through aid in loans and guarantees of sale to industry or the government stockpile. The steel industry, however, is going ahead without any government aid so far other than accelerated depreciation.

The planned capacity expansion is governed and limited by available raw materials. As a secondary effect, the pressures for additional raw materials are increasing prices, because of the higher cost facilities being put into production, and because of the higher capital cost involved in the development of new facilities. As one example between the middle and the end of the year, the increases in the market price of the various materials used by the United States Steel Corp. in the manufacture of steel amounted to about $70,000,000. This is in addition to the higher wage costs. In the case of United States Steel, employment costs are about 42 per cent of total costs.

Scrap remained in short supply during the year and one of the factors which helped alleviate it were heavy imports from Europe. Scrap which sold for $26.58 at the end of 1949 rose to $45.13 a ton by the end of 1950. Availability of high grade steel scrap may hold back some expansion in electric furnace capacity. This shortage will accelerate plans for direct reduction of iron ore as a charge for the electric furnace.

The supply of natural gas has been ample in general. Consumption of natural gas in 1949 by the steel industry totaled 399,000,000,000 cu ft which was 45 per cent over 1948. This year, however, in both the Pittsburgh and Cleveland areas limits have been set on the gas which may be used by industry.

Manganese remained a critical item as the Soviet government kept restrictions on supplies from that country. Other sources were expanded. Bethlehem Steel Co. signed up for a joint development on deposits in the lower Amazon Valley. It is claimed that 4,000,000 gross ton of 44 per cent ore have been proven in this location. Additional supplies are coming from the Gold Coast of South Africa. Exports of manganese from Africa and India should total over 1,000,000 tons this year, with about half from each location. In the South African development, a beneficiating plant for low grade manganese went into production which will produce about 100 gross tons per hour of concentrate.

A possible source of manganese is some large deposits of low grade 12 per cent ore in Aroostook County, Me. So far it cannot be developed economically.

A slag recovery plant in the Youngstown area is being set up to retrieve high grade manganese ore. This plant uses a two step process. In the first, the slag is recrystallized and in the second, the slag is crushed and ground and given a mineral dressing. This final processing breaks the concentrate into two parts, one of which contains manganese, iron and magnesium. Manganese and iron are separated by two reductions in furnaces. Cost of producing the concentrates runs $4 to $5.50 per ton of slag, and final reduction with electric furnaces runs from $8 to $12 a ton. The plant has a capacity of about 300 tons a day.

Recovery of raw materials from slag is also being used to obtain zinc and lead. At least three plants are in operation which recover the metals by remelting the slag and collecting the fumes which are converted to metallic oxides.

Cobalt is in very short supply and is all allocated. It is hoped that the cobalt problem will be solved in the near future as a mine and a mill is going into operation in Forney, Idaho which is expected to produce about 2,000,900 lb of metallic cobalt a year.

Although tin has been in adequate supply, the price soared and set all time records going as high as $1.62 a lb. These high prices will result in the return, in some cases, to the production of black plate cans.

Chromium was also cut off by Russia, and present supplies are coming from Africa, Turkey and India. Present supplies are adequate but our sources unfortunately are all foreign.

China cut off its tungsten supplies. This will create trouble as China has been furnishing about 50 per cent, particularly when it is considered that Korea also supplied an additional 15 to 20 per cent.

Zinc was short, particularly in the latter part of the year, and as a result several producers of galvanized products had to cut back production. Government stockpiling was a big factor in the shortage.

Nickel has been in short supply, although production in 1950 has run at the average level of the war years. Demand has resulted from stockpiling and military requirements which accent the high alloy steels. Non-military consumption of nickel is now under an NPA limitation order. The largest portion of the nickel consumed in 1950 was by the steel industry. The proportion of nickel steels to total production did not alter appreciably during the year. Stainless production in 1950 was about 750,000 tons and over 60 per cent of this was in the nickel consuming grades which accounts for the steel industry's high consumption. Idle nickel producing facilities are being put back into production with government money.

Programs for a marked expansion in the aluminum were outlined during the year. Under this plan, production capacity would be increased about 650,000,000 lb and about 440,000,000 lb of standby capacity would be returned to production. When this is done, total aluminum capacity will be about 2,500,000 lb a year. A portion of this program has already been approved.

Magnesium capacity is being increased from 50,000,000 to 240,000,000 lb. Most of this expansion will come from government standby plants.

Titanium came into its own during the year as a commercial metal and for the first time a list of standard sizes, base prices and extras have been published. Base price for sheet and strip is $15 per lb. A large production operation started at Sarel, Quebec where five new type electric furnaces have been installed to produce titanium ore. At this site is located the largest known titanium deposit in the world. This operation will produce both titanium and iron.

Miscellaneous — It has been predicted that ductile iron will become the third most important material from a tonnage standpoint and that production will hit 2,000,000 to 5,000,000 tons a year. This will put it after steel and gray iron. Output increased during the year to about 20,000 tons compared with 3500 tons in 1949. The metal may some day cut back requirements for steel castings.

One new development which will help stainless steel markets when defense needs relax enough, so that the marketing again becomes a problem, is a process which will color stainless in irridescent shades from yellow through purple. This will be very applicable in furniture and ornamental uses. In the process, chromium stainless steel is put into a boiling bath of water which contains a small amount of phosphorous.

Better understanding of what happens when steel hardens was obtained during the year with the low temperature work done at Massachusetts Institute of Technology. Contrary to the usual impression, it was found that hardening takes place more completely at low temperatures, and, even as low as the temperature of liquid helium. These studies indicate that steel hardening is a cooperative shear-like sliding in which atoms move in unison, and hardening does not seem to be the result of the shuffling of individual atoms. Cold working of steel is much more effective in these low temperatures also. The result of this study has been that for the first time quantitative predictions can be made of the behavior of steel treated for specific processes.

The increased emphasis on smoke control is being reflected at many plants who are installing preventive and corrective measures, whenever they can, particularly on new installations. In many cases this is being done even when not required, or to a more rigid operational standard than may be required.

An economical way of controlling dust emission in the open hearth may be used when the checker chambers are larger than necessary as they often are. In such units dust pockets may be built through the use of walls and baffles.

One company made a series of tests on sonic agglomeration of fume in ferro-manganese blast furnace gas with the following results. For effective agglomeration, frequencies of 1400 to 2000 cycles per sec and a minimum root mean square value of the resonant sound pressure peaks must be close to 20,000 dynes per square centimeter or 160 decibels, and the minimum retention time of the gas in the sound chamber must be over three sec. The conclusion was, however, that the method could be used effectively but the process in its present stage of development was not economical.

In line with a program of elimination of dirt in the atmosphere, Carnegie-Illinois Steel Corp. is installing a ferromanganese gas cleaning system at Duquesne. The unit includes a 220-ft bleeder stack which regulates pressure and automatically controls and burns the ferromanganese in burners in the boilerhouse. The gas cleaning system will be the first of its kind ever built and smoke and dust will both be removed.

Because of the pressure of operations it is difficult to carry on maintenance, much of which must be done on the fly. Some mills are being operated when repairs are going on. In other cases, the unit is shut down and a big force is put on the job in order to complete it in the fraction of the time normally required.

Foreign Developments — The steel capacity of Western Europe has increased about 18 per cent since 1939. This is not quite as much as the percentage increase in the U. S. This expansion has been largely the result of the Marshall Plan. Steel ingot capacity in Germany, Britain, France, The Saar, Belgium, Luxembourg, Italy, Spain, Sweden and Austria is now about 41,400,000 tons. This figure is exclusive of Eastern Germany and Russia. Contrary to American practice, most steel expansion in Europe has been financed through government programs whereas American expansion has been financed through private capital.

Construction costs are high and it has been stated that a 1,000,000 ton steel plant in Europe would require between $200,000,000 and $300,000,000.

Current expansion programs in Europe will give a total production in 1953 of about 70,000,000 tons exclusive of USSR. With ordinary peacetime markets, it is estimated that this will result in a surplus of about 8,000,000 tons of steel which may result in steel exports and dumping. Part of the future surplus is resulting from uncorrelated plans between the different countries. With present high demand in this country continuing, surplus European production will help supply some of this demand and this has occurred during the year.

Among the most important European developments were the final plans for the nationalization of the steel industry in Great Britain. Despite attempts by the conservatives to thwart this program, it is now going into effect. The act takes over all concerns making over

20,000 tons of steel annually and their integrated mills, forges and foundries. A large percentage of non-integrated mills and processing works which handle about 40 per cent of the gross output value will remain independent. Estimated production of steel in Great Britain set a record of about 18,000,000 tons compared with 17,400,000 in 1949.

Even Ireland is joining the steel production program and the government sponsored Irish Steel Holdings, Ltd. is planning to make steel sheets.

Steelmaking in Europe will be affected by the Schuman plan which was proposed during the year. If approval goes through as scheduled, the plan will start operation in June of this year. Under this plan coal and steel would be pooled in France, Western Germany, Italy and the Benelux countries. The pool will be operated by a 5 to 7 man group chosen collectively by the governments and the authority will have power to regulate production, prices, research, investment, modernization, tariff and trade policies, and the wage and labor policies of the coal and steel industries. The pool calls for elimination of tariffs and the freight differential for coal and steel products within the pool area. Some fear that the setup may develop into a high cartel. The biggest problem may be in obtaining co-operation from Germany.

Steel capacity in Western Germany is about 12,-200,000 net tons, but world conditions may result in permitting the Germans to expand their output to about 17,000,000 tons.

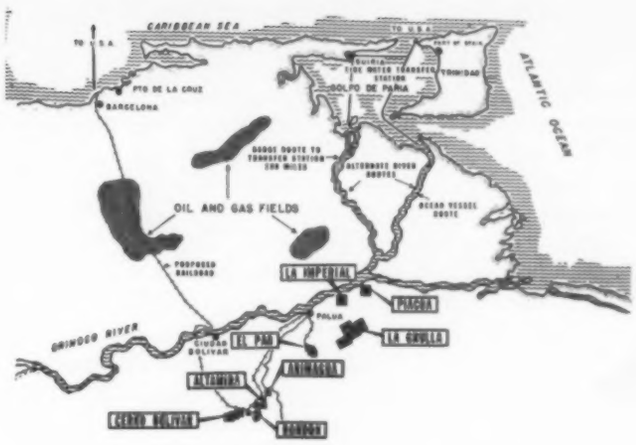
In Belgium a project for the installation of a semi-continuous hot strip mill at Ougree was approved by the ECA. The overall cost of this 66-in. mill is estimated at $16,800,000, and it should produce about 415,000 tons per year of plate and sheet. The unit includes a 4-high rolling mill and 4-stand finishing equipment. The project consists primarily of modernization rather than production expansion.

Plans are also being considered for the construction of a semi-integrated steel plant near Athens, Greece. Unit would include small open hearths, and sheet and shape-making facilities.

Little is known about exactly what has happened in Russia, although there is little doubt that they are expanding capacity as fast as they can. Their important developments are taking place in the Urals and in Siberia. It is estimated, however, that they will produce about 21,500,000 tons of pig iron in 1950, and 27,-900,000 net tons of ingot steel. It is also estimated that by 1955, steel production will be up to about 47,000,000 tons. Total production behind the iron curtain at that time should be 61,000,000 tons.

One European development which may free France from dependence on coke from the Ruhr is a process which will enable Lorraine coal to make good coke. The secret of the process is the addition of 15 per cent of what is known as "semi-coke" to the coking charge. This is known as the Marienau process and involves also that the mixture be ground more finely than usual and thoroughly dried before being placed in the oven. Another process which might have the same result is the Carling process which is basically a tamping process.

In 1950 France became the world's leading steel exporter shipping about 4,000,000 tons. Her first modern cold strip mill was completed at the Usinor works. The



Iron ore concessions in eastern Venezuela.

continuous hot mill which will furnish coils for this unit will be completed at Denain this spring.

Another large unit under construction is that being sponsored by Sollac, who are constructing a hot strip mill at Seremange and a cold reduction mill at Ebange, both in Lorraine. It is estimated that these mills will have have a minimum production of 600,000 metric tons after completion sometime in 1952.

Italy is joining the parade of countries installing strip mills and the Finsider Steel Corp. has concluded an agreement for a $100,000,000 continuous strip mill in Genoa.

Holland is also expanding and the Dutch parliament has approved expansion of Ymuiden Blast Furnace and Steel Works. Plate capacity will be increased from 140,000 to 205,000 tons. Plans are also being contemplated for the construction of a tinplate plant and a new hot strip mill.

Israel is joining the parade of countries who are going into the steel business and a rolling mill is planned for Haifa by Israel Rolling Mills, Ltd. Capacity will be about 60,000 tons annually.

In South America, the integrated steel mill at Huachipato, Chile went into operation. This is the first integrated plant in that country. It was built with American assistance and capital. Estimated initial capacity is 227,000 tons of iron, 260,000 tons of steel and about 200,000 tons of finished products.

Brazil plans to expand the Volta Redonda mill and expansion will include a second blast furnace, two 180-ton open hearths, rolling mills and an electrolytic tinning line. Finished steel capacity will jump from 301,000 to 467,000 tons and ingot capacity will go from 343,000 to 562,000 tons.

Acindar in Argentina is planning future expansion which includes an additional blast furnace, open hearths and blooming and billet mills. This is in addition to the wire mill, merchant mill and pipe mill which is expected to go into operation in the middle of 1951.

An integrated steel plant is planned for Colombia. This plant is being financed by an ingenious fund raising scheme which includes a special income tax which need not be paid by anyone who purchases stock in the company.

A bar mill is going into production at San Juan, Puerto Rico. Mill is being moved from an existing U. S. plant. Auxiliary facilities are also being shipped.

The expansion of iron capacity involves at least 9 stacks with a capacity of 3,600,000 tons. These include two for the eastern plant of U. S. Steel, one for Crucible at Midland, one for Jones & Laughlin at Cleveland, one for Republic at Cleveland, one for Armco at Middletown, one for Youngstown Sheet & Tube Co., Indiana Harbor, one for Great Lakes Steel and one for the west. These represent a very appreciable investment. An estimated cost for a blast furnace is $35,000,000.

Little information was reported during the year on the use of oxygen in the blast furnace. Theoretical advantages of increased heat in the hearth and bosh should help in smooth operation and increase the ability of the slag to absorb sulphur. The additional heating could be used to break down the steam which could be added to insure a uniform moisture content.

Present studies indicate that the blast furnace seems to have presently developed to about the most efficient design, and further improvements will mostly be in designing longer life into the various segments through the use of new and better lining materials, and in increasing the rate and uniformity of contact between the reducing gas and ore. To enrich the blast will require a somewhat different shaped furnace and the low shaft oxygen furnace offers possibilities for further conservation of coke. In such a furnace the reactions will be completed in a very short distance.

Blast furnace operation may be improved from the data which has been obtained during the year through the use of high speed photography in color to observe what is actually going on inside the blast furnace. These films will require much study before definite conclusions can be reached.

Studies made in the metallurgical department of Massachusetts Institute of Technology have developed information in what is believed to be the first equilibrium study of the distribution of sulphur in blast furnaces. This information should help in developing procedures which will enable the use of higher sulphur coals. The principal key seems to be that slags from which iron oxide is eliminated will readily absorb sulphur.

Another problem because of the increase in sulphur in coking coals is to eliminate the high sulphur bearing gases from those which are used in heating furnaces in order to prevent contamination of steel. There is one company who has in use a vacuum actification sulphur recovery process which removes the hydrogen sulphide in the coke oven gas and also the hydrogen cyanide. This is done by scrubbing with a solution of sodium carbonate which absorbs the gases. About 90 to 95 per cent removal may be obtained.

One method which has been found effective in desulphurizing in the blast furnace is to introduce lime into the slag. The chief problem is to introduce the lime uniformly and economically. One solution is to inject the lime through the tuyeres and as much as 40 tons can be introduced per day into a 16-tuyere furnace. The desulphurization takes place between the tuyeres and the hearth, so the economical move is to raise the lime content in the hearth slag and decrease it in the bosh slag. The method has been tried on a furnace in the Pittsburgh district, with a resultant decrease in coke consumption and with an increase in production. In the Pittsburgh district furnace, tests made showed the iron had a sulphur content of 0.06 per cent.

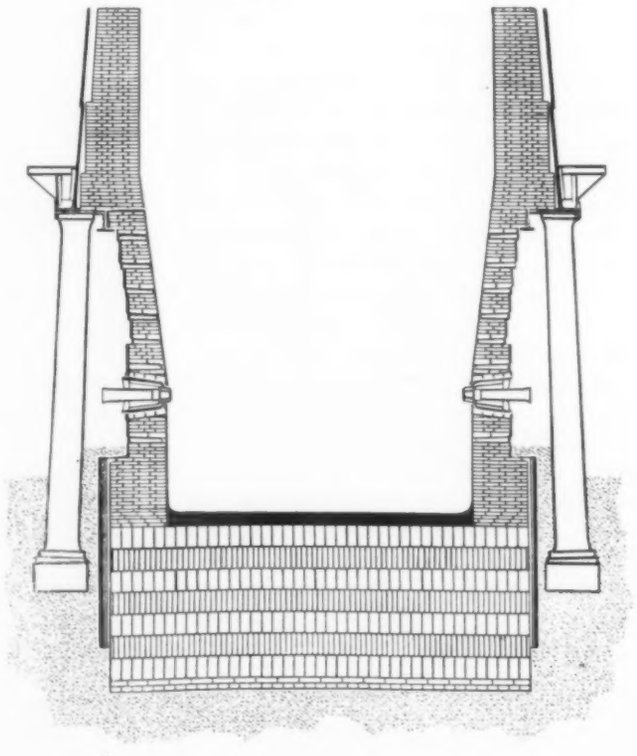
Iron production costs are still being raised because of the increase in coke and limestone needed to produce a ton of pig iron. Pig iron now requires an average of 0.357 tons of limestone, and 0.887 tons of coke per ton of pig iron which is 23 per cent more limestone and 7 per cent more coke than in the prewar years.

To increase blast control efficiency, one steel corporation recommends first, a two-way transmission system for signaling with an alarm that will stay on until acknowledged; secondly, low pressure alarms consisting of pressure switches which should be in all cold blast mains on the blowing room side of snort valve; third, high blast temperature alarm and, fourth, an intercommunication system providing independent communication between furnace front and blast source.

One blast furnace has had automatic control applied in an attempt to correct furnace irregularities. This method of control gages the changes in buoyant effect of the stock charge in the shaft by a measurement of the changes in the resistance of the furnace charge voids to the flow of furnace gases. A top gas pressure instrument is interlocked with the control system to insure proper corrective action under all conditions. Operating results to date are that the installation not only improves the operation of the furnace but solves the air pollution problem by eliminating bleeder operation.

A new blast furnace design uses an all-carbon lining. This furnace is of all welded construction to prevent any air from getting into the hearth area. This new American blast furnace is also gas tight, which will allow pressure blowing. The carbon block is carried up to within 30 ft below the stock line. Among the advan-

A sillimanite ramming mix pad is shown on top of hearth blocks in a blast furnace bottom. High alumina refractories such as this offer operators a possibility for improving lining life.



tages are that the welded steel construction on the carrying shell and columns is cheaper than the ordinary mantle and column design, expensive copper cooling plates are saved, less water is required since the shell is cooled by spraying, and maintenance costs should be less.

Great Britain has three all-carbon blast furnaces in operation. The linings have stood up well and the increased production and savings have been sufficient to more than cover the higher initial lining cost. Among the advantages claimed are increased campaign life, elimination of stack cooling, cheaper and simpler hearth cooling, thinner lining requirements and fewer scabs. One of these furnaces was blown in during 1949 and since then has made more iron at a lower coke rate than its previous campaign. The extra cost to make this an all carbon furnace was $22,000.

Great Britain started operation during the year on the first blast furnace with high top pressure blast to be put into operation outside the United States.

The largest furnace in Great Britain went into operation at the Steel Co. of Wales at Margam. This furnace went into production with a 25-ft 9-in. hearth and is rated at 1000 tons a day.

The tuyere design has changed little for a number of years, but one developed during the year varies considerably from the previous round tuyere. The new design has two different diameters at the nose and is divided into segments with the opposite ones having the same diameter. The purpose of this is to concentrate a portion of the blast so that it will penetrate further into the center of the furnace, and the large diameter segments spread the area of the blast over a larger hearth area which is important in the large diameter furnaces.

Further work on direct reduction was studied during the year at several locations. Normally it is much more economical to bring the ore to the coal deposits which is usually a steel market center than it is to bring the coal to the ore deposits. As a result the direct reduction process would be more advantageous at remote ore locations. Studies made by the Ontario Research Foundation indicate that with a market of over 600 tons per day, a standard blast furnace is the only choice. If the market of the area is greater than 400 tons a day but less than 600 tons, the economical choice is between a small blast furnace or the Tysland-Hole electric furnace. If the market is less than 400 tons today the choice is between the electric smelting and Wiberg-Soderfors sponge iron process. The electric method in both cases is, of course, dependent on the power rate and is also of advantage if pig iron for foundry is the product required. It has been estimated that the net energy required for these various processes with credits for recovered heat are 11,000,000 Btu for blast furnace, 11,200,000 Btu for the Tysland-Hole electric smelting, 8,200,000 Btu for the Wiberg-Soderfors sponge iron and 14,500,000 Btu for brick kiln sponge iron. There is little doubt that no process can compete with the blast furnace in regions which contain heavy industry or where large quantities are required.

France is trying to put the United States Bureau of Mines sponge iron kiln at Laramie, Wyo., back into operation. Shipments of low grade French ore are being made to the blast to attempt to make iron without sulphur which is as good as the Krupp-Renn.

A new process for neutralizing waste pickle liquor uses molten blast furnace slag. The slag is poured into the liquor evaporating the water and neutralizing the acid, and the resultant production is a granulated slag which can be used in raw commercial fertilizers.

A new coke oven design was proposed during the year which eliminates the cross-over flue system. It is claimed that the unit will maintain economical generating efficiency for underfiring without requiring counter flow of gas at the outside regenerator walk.

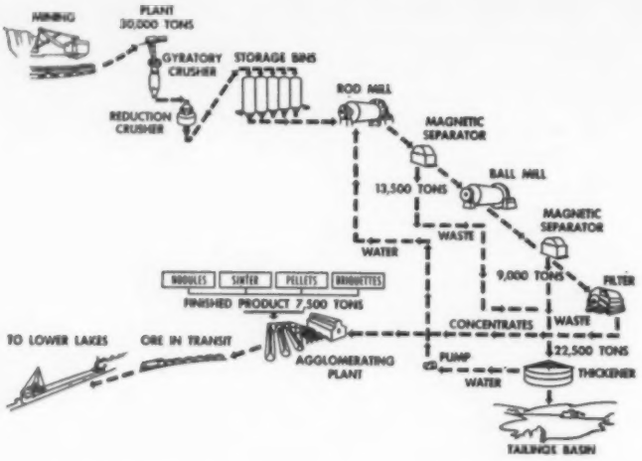
At least one coke plant is using fuel oil as an absorption oil in the recovery of light oil from coke oven gas. Even with the use of the cheaper oil, the operation has been successful in that there has been no bad effects on recovery, cleanliness or quality.

Blending stockpiles have been used for some time to increase yield for iron ores. For the first time a blending system has been designed to blend coal for use in coke making and this unit went into operation in England. The conveyor system is used in the blending plant which is at the John Sumners works. At this plant, the different coal grades are distributed by conveyor in thin layers which run the length of the beds. A harrow like reclaimer is used after the desired height has been reached which rakes the coal down from each layer of the bed, and the conveyor then collects the fully blended material and takes it to the coke ovens.

There is little likelihood of the world running out of iron ore. One of the largest deposits exists in the Damador River Valley in India. In this valley, it has been estimated that there are reserves of 15,500,000,000 tons of coal and 8,000,000,000 tons of high grade iron ore.

Ore brought down on the lakes this year totaled about 78,300,000 tons, and an additional 1,000,000 tons was brought in by rail. This is about 10,000,000 tons more than was moved in 1949. However, the stockpile on December 1, 1950 was only about 40,500,000 tons which may mean a possible shortage if there is any delay in opening up the lakes this spring.

Ore, the basic raw material in steelmaking, has been the instigator of most of the activities in raw materials. A year ago it was difficult to tell what would be a source of our future iron ore. The picture is now somewhat clearer. Extensive developments are underway in the Lake Superior region to develop the taconite resources. If the operations of the Jones & Laughlin Benson mine are any indication, most of the initial work will be on the magnetic taconites. The Oglebay, Norton & Co. have plans underway to construct a mill at Beaver Bay mine to produce 10,000,000 tons of concentrates. The U. S. Steel Corp. has authorized $200,000,000 which should build a concentrator fully as large as the preceding one. There will also be a very marked trend in this country to the importation of high grade ores. As an example of this trend 3,000,000 tons were imported in 1946. By 1949 this had risen to 8,300,000 tons. Large factors in our future ore supply will be the Labrador, Quebec development, because during the year plans were made and capital was raised to go ahead with this project. The Bethlehem Steel Corp. deposits in Venezuela are now supplying ore to that company. During the year, U. S. Steel Corp. announced the discovery of several new and large deposits of high grade ore in Venezuela, and are going ahead with developing the mines. This deposit will supply



Typical magnetic concentration process for taconite.

raw material for the new U. S. Steel eastern plant, and may also be shipped inland to the Pittsburgh and Alabama districts. The Steel Rock Development also offers a large supply.

The United States Steel program as announced by the corporation provides for the development of 25,000,000 tons of annual iron ore capacity from new sources during the twenty years from 1950 to 1970. These new sources, including taconite concentrates, should provide more iron units per ton than the present average ores which will thus result in more pig iron production per furnace.

The new U. S. Steel Venezuelan resources at Cerro-Bolivar will be developed by a newly formed company, the Orinoco Mining Co. It is expected that ore will be coming into this country within the next five years. Eventual development is expected to be about 10,-000,000 tons annually.

Another discovery was made in Venezuela at San Isidro, located only 20 km to the southwest of Cerro-Bolivar. Although United States Steel knew about this deposit it was not able to file on the whole area and this area has been taken over as a government domain. Official reports list over 300,000,000 tons at this location.

It is not expected, however, that the Labrador-Quebec deposits will deliver any ore to Seven Islands until about 1955. It is expected that the price will be competitive with Mesabi ore delivered in Cleveland. Financing in the amount of $200,000,000 for the development has been set up, and initial construction contracts have been let. A 360-mile railroad has been started. Proved high-grade ores exceed 400,000,000 tons. The operating company is the Iron Ore Co. of Canada. Companies in the venture are Armco Steel Corp., Hanna Coal & Ore Corp., Hollinger Consolidated Gold Mines, Ltd., Hollinger North Shore Exploration Co., Ltd., Laborador Mining & Exploration Co., Ltd., National Steel Corp., Republic Steel Corp., Youngstown Sheet & Tube Co., and Wheeling Steel Corp.

Although it has not received as much publicity as the other sources, Steep Rock Iron Mine shipped 1,215,000 tons of high grade ore this year and it is expected that it will ship 10,000,000 tons annually inside of five years. It is claimed that the reserves of high quality ore at this deposit exceed that of any other range, old or new, on this continent.

Although Brazil has extensive ore reserves nothing happened during the year which would indicate that they might be drawn upon in the near future.

The Jones & Laughlin Steel Corp. began work on the Negaunne Mine in Michigan which is expected to produce about 1,000,000 tons of ore annually at peak operations. This thus becomes one of the largest underground ore mines in the world.

Bethlehem Steel Co. is also prospecting for ore in Becks County, Pa. This is part of their program for prospecting in the vicinity of old workings.

So far the present research on beneficiation indicates that no one single method will meet all different requirements, nor will one type of treatment plant answer the needs for the various sections of the taconite deposits.

In 1950 about 25 per cent of the iron ore shipped from the mines was in the form of beneficiated and concentrated ores. This material may contain more than 70 per cent iron and as a result the trend towards lower production in the blast furnace may be counteracted because such ore results in better production.

In 1949 the total iron ore production in Minnesota was 56,826,000 tons of which 16,808,000 tons were concentrated. Beneficiation on Mesabi ores is now being applied to about 26 per cent of the production on that range. However, even the straight wash ores which were first beneficiated are repeatedly being exhausted and much of the remaining siliceous ores are too coarse to respond to straight wash treatment. The sink and float concentrations of the heavy media process works well with ores of this type although the lower size limit particularly in this treatment is 3/16 in.

Heavy media separation was used most widely during the year, and 13 plants were in operation during 1950 in the Lake Superior Region, two plants in the Alabama area, one in Texas, one in Canada and one in Sweden. Capacity of these units was estimated at about 10,-000,000 tons. The cost of low grade hematite processed runs about 10¢ a ton.

The magnetic taconite ores which are easiest to treat are hard to drill and the jet piercing method has worked well on them. One part of a plant in operation has a crude ore capacity of 1800 tons a day. At this plant, the concentrate filter cake is pelletized by tumbling in a revolving drum. The final agglomerate from this plant could be processed in a conventional sintering plant, but experiments are also being tried with a circular shape furnace. Although the pellets are porous they are sufficiently hard for charging in the blast furnace.

A new method of pelletizing iron-bearing fines was developed by the Ontario Research Foundation and it produces pellets suitable for open hearth feed or blast furnace reduction. Since very fine materials such as taconite concentrates are difficult to sinter cheaply, pelletizing appears to offer a less costly process. The process requires that feed ore plus moisture is fed into a pug mill, then through a rotary shredding knife and through an auger from which it is extruded through a die. Vacuum is maintained in the operation. Pellets as large as 3 in. in diameter can be made in cubical or cylindrical shapes. Estimated production cost runs close to 33¢ a ton.

The Oliver Iron Mining Co. started construction on a new type agglomeration plant at Virginia, Minn. This plant will be the first combination sintering and nodulizing pilot plant on the Mesabi Range and will have a capacity of about 1,000,000 tons per year.

The Reserve Mining Co., which is owned by Republic and Armco Steel Corp., has requested permits which will enable them to go ahead with the construction of an annual 300,000-ton pilot plant at Babbitt, Minn., for the production of taconite pellets. Existing facilities built about 1920 will be used in this operation. A 25,000 kw power plant is part of the plan. The magnetic taconite being produced by Reserve Mining Co. is first ground, then the iron bearing powder is separated by magnets, and these are then formed into pellets about 1 in. in diameter having an iron content of about 60 per cent.

It has been estimated that $15 to $20 will be required as capital investment per ton of annual capacity for producing taconite concentrates.

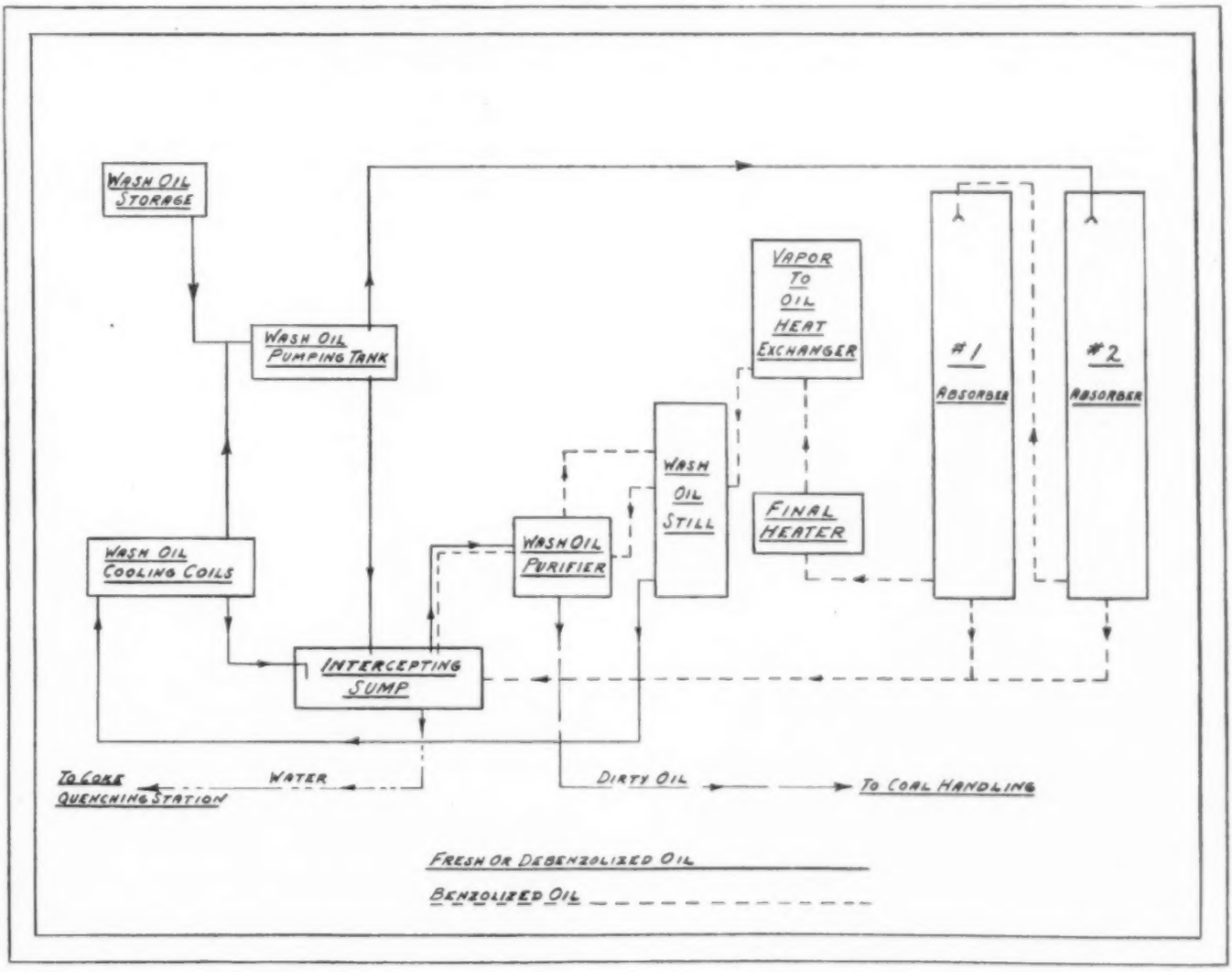
A new magnetic separator for iron ore operates on a somewhat different principle than previous devices. In the separator, a rotating drum is maintained on a box and stationary magnets inside the drum provide means from which iron ore is extracted from the taconite. As the mixture passes beneath the rotating stainless steel drum, the magnets draw the magnetic iron ore from the mixture to the drum and the drum movement carries the ore through a washing zone, and then away from the direct pull of the magnets, depositing it in a trough leading to the future grinding stages. The system is already being tried in the Aurora, Minn. plant of the Erie Mining Co.

Coal prices went up during the year as a result of increased labor costs. However, coal will not become an urgent problem for some years to come, and coal requirement of the steel industry will undoubtedly be met from sources in this country. New beds are constantly being found, one example, this year was the discovery of more than 600,000,000 tons of semi-smokeless coal in the lower beds of the Georges Creek Field, Allegany and Garret Counties, Md. With washing, these beds should furnish a new metallurgical coke.

The county by county survey which the Bureau of Mines is making should result in additional discoveries.

The increasing sulphur content of coking coals means that more and more work must be done to control it which in turn will require more and more washing and beneficiation particularly in the product from the mechanized mines.

The flow diagram for the wash oil system at Pittsburgh Steel Co.'s plant at Monessen, Pa. is shown here schematically. Use of fuel oil has resulted in marked economies.



STEELMAKING

Total steel production for the year 1950 was about 96,500,000 tons. It had been thought that the year would reach 97,000,000 tons but the big snowstorm late in November prevented this.

There were no startling developments or changes in steelmaking equipment or processes during the year. The basic problem confronting the steel operators, and which they successfully solved, was to obtain every pound of steel possible from equipment and to keep downtime to a minimum. As to be expected there were refinements in procedure.

The use of oxygen in the open hearth has become standard operating procedure in some plants, particularly for decarburization. At one plant the gas is fed into the furnaces through two water cooled ports in the backwall opposite charging doors Nos. 2 and 4. A replaceable copper nozzle is on the end in the furnace which has a single 17/32-in. hole which feeds 30,000 cfhr. The oxygen stream strikes the bath at an angle of 60 degrees from the horizontal with the nozzle about 7 in. above the slag. With this procedure there has been no excessive splashing or foaming, and no harmful effects on furnace or roof life. Oxygen is started about 30 minutes before heat is tapped about which time the carbon level is about 0.30 to 0.40 per cent and about 45 cu ft of oxygen per net ton of ingots are used. Carbon drop averages 0.01 per minute. The procedure reduces the fumes which were present when the lance was used.

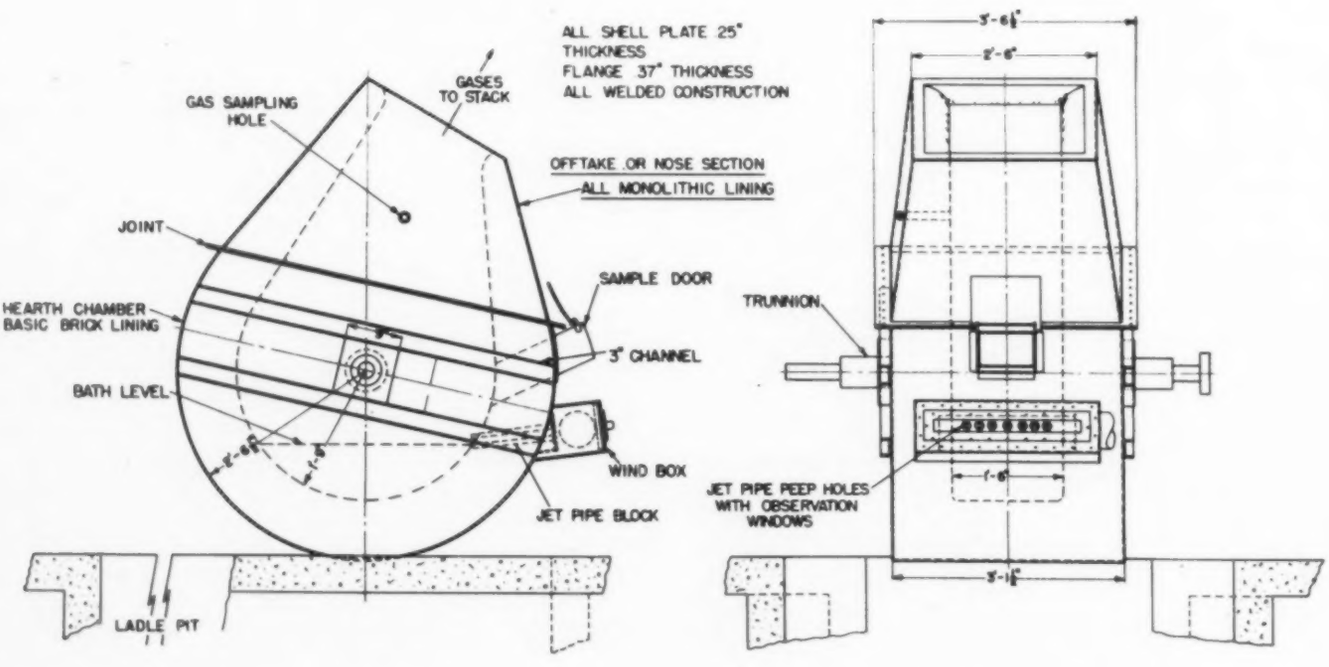
In a questionnaire which was circulated to the industry, out of twenty plants which participated, about 40 per cent stated that they used oxygen for decarburization. One plant uses it for flame enrichment only, and three plants use oxygen for both combustion and decarburization. None of the plants have had to change their fuel practice to any extent. The average of the returns indicate that the use of oxygen for decarburization increases production (charge to tap) 0.45 net ton per hr, and in combustion increases production 1.45 net tons per hr. Average consumption of oxygen for decarburization is 89 cu ft per ton and for combustion is 325 cu ft per ton.

Operating results with the 550-ton open hearth at Weirton have been so successful that additional large furnaces have been or are under construction, one of these at Great Lakes Steel. The Weirton furnace has cut rebuilding costs 25 per cent per ton of steel because of the size of the furnace and the use of basic brick. Fuel consumption is down, and the unit conserves from 14 to 16 gal per ton. The furnace is used with a 35 per cent scrap charge and charging time varies from 4½ to 6 hrs.

The use of the all-basic furnace is proving to be uneconomical according to the reports of several operators during the year. A trial furnace operating in the Chicago district has now gone for 2000 heats in four campaigns. This unit gave increased production which was an economical advantage, but this was more than offset by the higher cost of the basic construction and the higher rate of fuel consumption. These studies are being continued. Similar results have been reported by the company who first started work on the all-basic furnace, and this company is no longer employing the practice.

Refractory materials and design continued to improve during the year. One interesting development is a double hung pendulum action insulated refractory arch, whose use is claimed will not only reduce number of shapes needed, but which will cut furnace roof construction and maintenance costs. Because of the design, mechanical spalling is reduced, since the design allows differential expansion of the refractory elements. The construction can be attached to existing steel framework and is normally suspended from tubing which is attached to the overhead beams and girders.

Experimental turbo-hearth chamber for surface blowing.



A new gun has been developed which shoots a wet refractory mix at high speed, and which is very effective in relining items such as cupolas. No hand ramming is required, and relining costs have been cut 50 per cent. Lining thicknesses up to 10 in. can be applied.

In the refractories field the use of semi-silica brick has overcome trouble which is encountered in some high walls from leaning inwards. This is a grade which runs about 77 per cent SiO_2. One of the features of this brick is that it resists structural spalling. They are also resistant to thermal spalling and as a result will give excellent records in many furnaces. The use of fire clay graphite brick in hot metal ladles has shown that these brick resist the high oxide slags very well. They also give good use in such items as blast furnace splash plates and pig machine runners.

A removable nozzle plate which is detachable from the bottom of a hot metal ladle has cut down the time required to get the ladle ready for pouring the next heat. The old nozzle can easily be broken out, and a new one inserted; the time necessary is only 12 to 15 minutes.

At the Armco Steel Corp., Middletown, Ohio, a novel method of scrap charging has been put into operation. Four special hydraulic elevators are installed to serve the three furnaces in the new open hearth plant. These elevators have 10 × 20 ft platforms which carry the charge buggies from yard level up to the floor level. It is estimated that the time needed to charge a furnace is cut from 3½ to 1½ hours, or 55 per cent. Material is brought up from the ground to the charging level in about 25 seconds and 15,000 lb loads can be raised. The complete round trip takes two minutes.

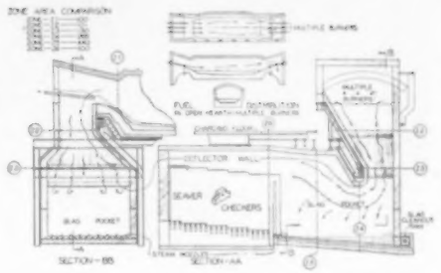
Electric furnace output and capacity rose faster in 1950 than either the open hearth or the bessemer. The war needs were strongly reflected in this production. As of July 1, 1950, the country had over 7,000,000 tons of electric furnace capacity. Some units have a capacity of almost 100 tons.

Oxygen is being used in the electric furnace. At one plant which has a 70-ton and two 35-ton electric furnaces, the oxygen is fed into the bath at the slag-metal interface by a ½-in. lance inserted in the wicket holes. The quality of the stainless steel is definitely improved. The use of the oxygen lance also made possible the charging of stainless steel scrap which previously would have had too much carbon pickup from the electrodes.

In an English furnace, a bath of molten glass covers the electrodes at the bottom of the furnace. In addition to preventing the usual oxidation of the electrodes, the glass acts as a resistor.

Top charging is meeting additional favor, and one steel company is planning on expanding its capacity about 140,000 tons a year, from its present 420,000 tons, by converting four of its furnaces to top charge.

Steelmakers have been finding that control of the bath temperature has improved production and decreased operating cost. The control of the temperature through the use of pyrometers and immersion type thermocouples gives better pouring practice, better mold life, fewer stool stickers and less ladle skull formation. The latest type thermocouples have a silica top incorporated in them which is cemented into a graphite plug. This amplifies the maintenance of the couple inasmuch as a new top is inserted for each



Suspended refractory deflectors remove heavy solids from gaseous products.

reading. The thermocouples used are platinum and platinum-rhodium.

The newer instruments are giving better control. At one plant phosphorous determinations are made in two minutes using the spectrographic method with Geiger photoelectron tubes.

A new high frequency induction heating instrument has been developed which will determine carbon content in the range of 0.05 to 3.0 per cent. The method gives extremely rapid results and the time may be as low as 2½ minutes for a sample.

A great deal of progress has also been made on continuous casting, and it appears that it will fit into the steelmaking process economically for some products and in some locations. Oval sections are now being cast with areas of 25 to 40 sq in., and larger ones will be possible in the near future, perhaps up to 100 sq in. It has been advocated that such a process might well fit into a plant such as the proposed New England steel plant because of its low capital requirements and high steelmaking possibilities, inasmuch as ingot equipment,

The elevator on which the scrap buggy with pans is brought from the ground level to the open hearth floor is seen just leaving the ground floor.

Powerful X-rays from vertical tube at left ionize atoms of iron and alloying elements that compose the serrated blade, making them fluorescent. The Geiger counter, on quarter-circular track, identifies and measures intensity of rays. This method of steel analysis, thus far experimental, promises a charted result in the space of one minute. One great advantage is that the steel specimen needs no special preparation and remains intact.

soaking pits, blooming mills might possibly be eliminated.

Another company, which is using the Rossi process, is apparently planning a unit which will be used for both carbon and alloy steels. One Rossi unit has already been in operation which casts steel at 10 to 15 tons an hr. With new understanding on metal solidification and with a new mold, it is expected that 50 to 60 tons an hr can be cast. The company which already has one of these machines has just ordered two more. The Rossi continuous casting method claims benefits aside from capital investment which will result in a saving from $8 to $12 a ton in casting carbon steels and from $60 to $100 a ton in casting stainless grades.

Experimentation has been going on in an Ohio plant on the Goss continuous casting machines, and a British company is building a machine with a 4 × 16 in. mold, 5 ft long which will be capable of casting 1000 lb a minute. The unit casts slab ingots and the structure is said to be fine grained and dense with nearly perfect surface.

Another new continuous casting method is the Jacquet. In this system, the molds are directly connected with the ladle in a horizontal position. Because of rapid ingot cooling, the structure is uniform and segregation is at a minimum. This process is described in greater detail in another article in this issue.

In an unusual practice, a Canadian steel company has found it practical to ship 30,000 lb ingots, 200 mi with a drop in temperature of only 1700 to 1517 F. This cuts two months from that company's old processing method. The ingot, after being poured and stripped, was placed in a cast iron box which was insulated with vermiculite, and shipped overnight by rail.

A new steel ingot hot top has been developed which will stand up for as much as 100 heats. It consists of a cast steel flask which is lined with a special refractory brick. Another new hot top used on 6 × 6 in. ingots is finned and it is reported that there was no ingot discard.

A three year investigation on the use of fireclay in hot tops has recently been concluded. Tests were made on tops from 3 × 3 to 25 × 25 in. ingots. As a result of the program, it is expected that hot tops may be used with reduced volumes, through the use of light weight refractory materials and insulating covers.

One company has increased its ingot mold yield from 78 to 85 per cent through the use of an exothermic liquidizer compound. This company makes ingots which range from 8 × 8 to 14 × 32 in. The material generates heat and when once burned, it changes to an insulating blanket which prevents additional heat loss. Material is also used in ladles to prevent skull formation.

What is believed to be the largest ingot ever made was produced in a mold 134 in. in diameter, the ingot weighing 720,000 lb. The resultant product was used for a forging.

ROLLING

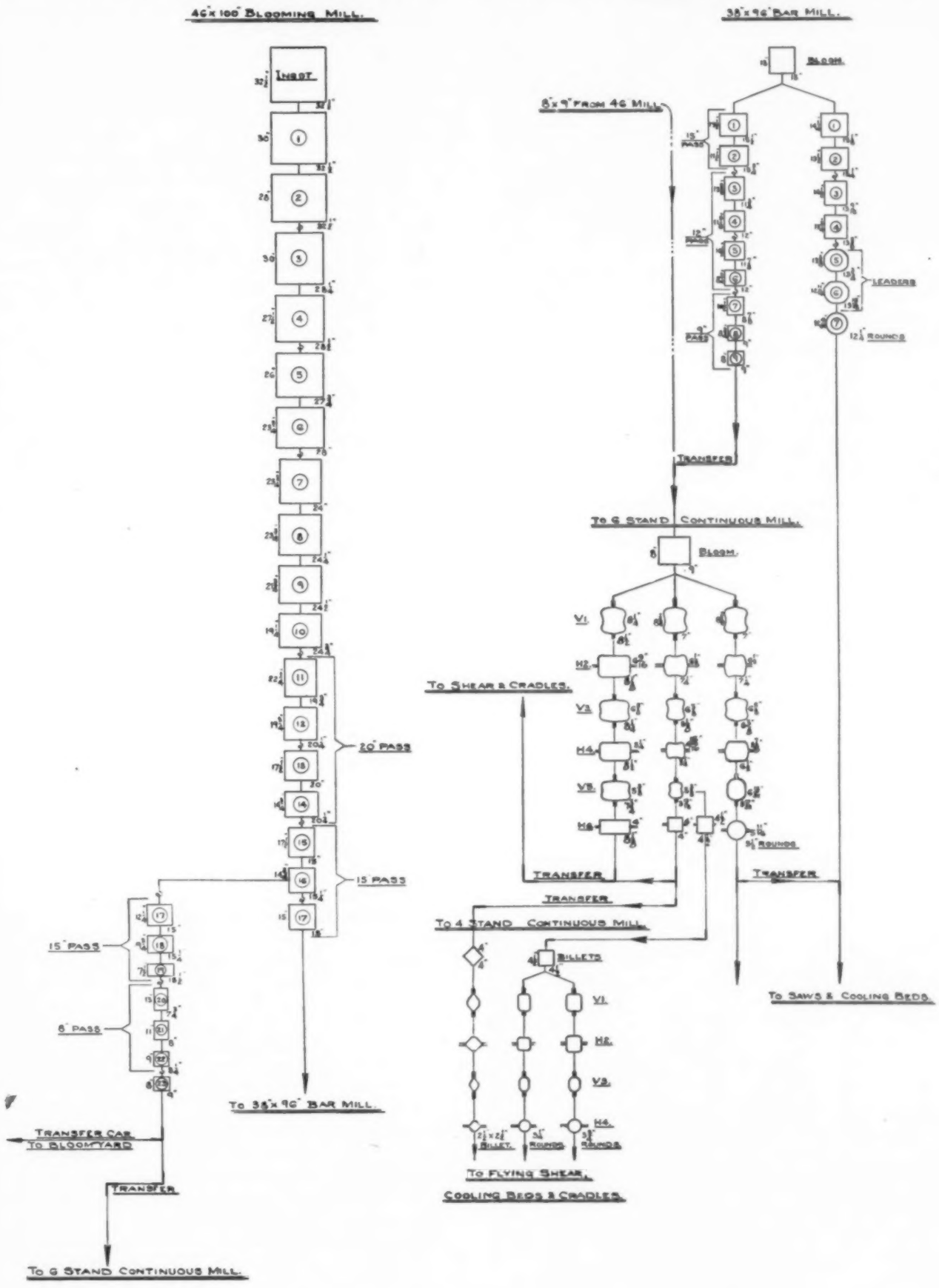
The demand for pipe resulted in perhaps greater expansion in this segment of the rolling mill field than in any other phase. A number of new units went into production and construction was started on several others.

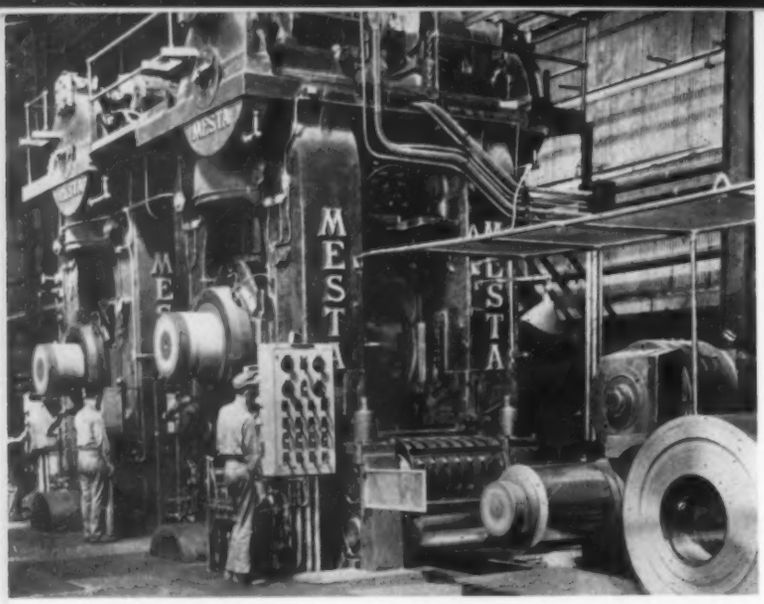
At the McKeesport works of the National Tube Co., the new electric weld mill went into operation. This

The pipe in the new mill at the National works of National Tube Co. is welded both inside and out with a submerged twin arc welding machine.

unit has an annual capacity of 100,000 tons of pipe and can produce pipe up to 36 in. in diameter. Among the unusual features of this mill are two automatic, submerged arc welding machines and the expansion operation which is used after the pipe has been made, both as a test and also to give the pipe a certain amount of

The flexibility of the No. 4 blooming, bar and billet mill at National Tube Co.'s Lorain works is illustrated by this diagram.





The trend in temper mills is to 2-stand units such as shown in this illustration.

cold work. The diameter of the pipe is expanded about ½ in. in diameter.

A similar mill also went into operation at the plant of the Consolidated Western Steel Corp. at Orange, Tex. This latter unit is indicative of a trend which has been locating mills in the southwestern area of the United States or in the market area for pipe. Another new mill in this area that went into production was the A. O. Smith and Sheffield Steel plant in Houston which can make pipe from 8⅝ to 36 in. in diameter. The pipe of this mill is welded in a flash welder.

Another large pipe mill is under construction in which the welding will be done by the induction method. This unit is designed to weld 36 in. pipe with a ⅜ in. wall at speeds of ½ in. per sec.

A new electric welder has been developed which is expected to give better welds in electric weld tubing. This unit uses surface contact electrodes to carry the current across the seam of the tubes and is an air operated intermittent machine. It is said that the grain structure is almost equal to that in the parent metal.

Another new electric weld pipe mill was built in the southern district. This mill also uses the submerged arc process and can handle line pipe from 20 to 30 in. in diameter with wall thicknesses of ¼ to ½ in. Welding speeds of about 48 in. per minute are used depending on the wall thicknesses.

The new seamless mill at National Tube Co.'s Lorain works is almost completely automatic. It has a rated capacity of 18,000 tons per month in pipe sizes 2 to 4 in. The 2 in. pipe is delivered from the 12-stand tension reducing mill in 142 ft lengths in speeds of 1300 fpm. Only one size of round billet is employed regardless of the final diameter of the finished product.

An interesting feature at the Lorain mill is the automatic pipe finishing equipment. An unusually large amount of automatic equipment is set up in this mill, which is used for cutoff, chamfering and threading. The equipment includes two duplex cutoff machines, six duplex chamfering machines, four duplex threading machines and handling tables for conveying the pipe to and from the chamfering and threading machines. An unusually large amount of pipe can be processed rapidly and in a relatively small area.

Extrusion methods of producing shaped sections are finally becoming an important method of steel production. One company has decided to build a $1,000,000 plant for the fabrication of tubes of ferrous metals and alloys in complex shaped sections. It can thus fabricate materials and sections which are impossible to do by any other method. The key to the process is a new idea in the lubrication of the hot metal (glass is used as a lubricant) and in the thermal insulation of the die and ingot holder. This Ugine-Sejournet process is an operation in France at the present time where it was developed during the war. Several other companies are interested in the process.

The National Tube Co. announced that it will construct a large extrusion plant at the Gary works which will manufacture high alloy seamless specialty tubes as well as pipes and bars. This will be the first application of the process on a large commercial basis for the manufacturing of seamless tubes in this country. Unit will consist of a 2500-ton hydraulic extrusion press which will produce tubes ranging from 1½ to 6½ in. in diameter with wall thicknesses up to ¼ in., in lengths up to 60 ft.

Artillery shells are now being made by cold extrusion in a production operation. As much as 40 per cent of the steel is saved, machining is reduced and required properties can be obtained with low carbon steels thus saving on alloys.

Extrusion is also being used by one of the aluminum companies for sheet. Sheets can be made with stiffeners by first extruding a finned tube, cutting the tube lengthwise, and flattening the piece.

Capacity expansion for the production of sheet and strip products occupy the attention of many of the rolling mill designers. When it is considered that the present day tandem mill can produce at the rate of 2800 lb of steel in one minute, and that the old fashioned hot mill with a nine-man crew would produce only 14,000 lb an eight-hour turn, it is easy to understand why this was so. However, the hand sheet mill which appeared to be going completely out of the picture

This simple slab shear provides positive control, quick release, unobstructed access to shear throat and reduced maintenance costs.

obtained a new lease on life because of the accumulated demand brought on by the strike at the end of 1949, and by the requirements of the automobile and appliance industries, which in some cases made it economical for the sheet user to pay premiums for delivery. The next trend in this field comes as the result of defense needs, and it appears that the light plate situation may require that some of the hot strip mills be set up to roll the lighter gages as they did during the last war. One factor also is that appreciable tonnage of plate is being allocated by the NPA for such items as the freight car program.

The first hot strip mill in eastern Pennsylvania went into production during the year at the Conshohocken plant of Alan Wood Steel Co. This is a 30-in., 6-stand hot strip mill which was purchased from another producer and modernized. Present annual capacity is about 218,000 tons.

The new strip mills in Europe at the Ebange and Seremange plants of Sollac mean that Europe will also have modern facilities for producing strip.

Cheaper aluminum strip and sheet will result from the new mills installed by Alcoa at Davenport, Iowa. This is the world's largest aluminum sheet and plate mill, and the 144-in. hot mill can produce plates up to 140 in. wide and the 100-in. continuous mill rolls sheets 90 in. wide.

Going to the other extreme is a small experimental mill built for Armco which rolls electrical steel in gages as small as 0.00015 in. Work rolls are only $\frac{5}{16}$ of an in. in diameter. Production capacity on this mill will definitely not be on a tonnage basis.

The new hot rolled strip mill at McLouth Steel is a 4-high reversing mill. This design has given that plant an unusually large capacity, at a relatively small capital investment. Mill practice at this plant consists of rolling ingots to plate thicknesses on the blooming mill, and then rolling the strip on the single hot mill reversing stand. The blooming mill is extremely fast as a twin motor drive and can roll an ingot every five minutes. One of the reasons why production is high in this mill is the design of the electrical control.

A 2-stand, 4-high tandem mill in an eastern plant which is used to break down stainless and carbon steel is said to be capable of reducing strip gage as much as 40 per cent in a single pass. Both units have two backup rolls and two work rolls which take 22 in. carbon and 18 in. stainless with speeds up to 800 fpm in gages from 0.16 to 0.010 in.

There was a further trend to the semi-continuous hot strip mill with a reversing roughing stand and three or more continuous finishing stands. Additional units were also installed which had mercury arc rectifiers for the power source on the finishing stands with the usual motor generator set furnishing power for the reversing rougher.

A new 54-in. semi-continuous mill was built in which none of the finishing stand motors are geared. The 4000-hp, 40/80-rpm, twin drive of the roughing stand is powered with a 3500-kw synchronous motor generator set. Each of the four finishing stands has a 3500-hp direct drive of 55/110, 90/180, 125/250 and 150/340 rpm motors whose current is furnished with two 5000-kw mercury arc rectifiers.

The highest powered 4-stand tandem mill to be built is a 66-in. mill with a maximum speed of 3000 fpm.

There was a trend for reversing cold strip mills with larger and larger end drives. One producer of alloy and specialty steels is installing three 4-high reversing cold strip mills with individual drives on each backup roll.

In temper mills, the twin stand is meeting favor, and a 6000-fpm, 2-stand unit is under construction. In the unit a conventional 2000-kw generator provides power for all drives. A solid bus scheme is used because among other factors, the work done by tension regenerates power which allows the use of less generating capacity than if individual generators were used.

Individual generator systems of control continue to be the choice for all high speed tandem cold strip mills as well as for larger low speed mills. A tin plate and light sheet mill is now being planned which will be faster than anything heretofore and will have a top speed of about 7000 fpm.

The first rolling mill in the Saquenay Valley in Quebec is a rod mill built for hot rolling aluminum. It was found economical to install a fully automatic Belgian mill. This mill rolls 100,000 lb of aluminum in an eight hour shift, taking 6 × 6-in., 125-lb ingots down to $\frac{3}{8}$ in. rod in 22 passes.

The No. 4 blooming bar and billet mill at the Lorain works of National Tube is one of the most modern and flexible production units ever built. The blooming mill is a 46 × 100-in., 2-high reversing unit with front and back tables, double rack type manipulators with tilting fingers on both sides and individually driven feed rollers. The blooming mill will roll 32½ in. ingots to 15-in., sq blooms which are then further reduced in a 38 × 96-in., 2-high reversing bar mill, which is utilized as a secondary mill to further reduce the bloom to 9 × 8 in. or to large tube rounds. Feed rollers have been eliminated because of the long bloom lengths. As an example of the flexibility of operations, the billet and bar mills can produce a wide variety of products from the 9 × 8 in. blooms, as the mill is equipped to roll 4 × 5, 5⅝ × 4, 7 × 4, 8 × 4, 9 × 4 and 4¾ and 5½ in. diam rounds with the same roll and guide setup, and with the ability to shift between any of the above sizes by mere pushbutton control.

A number of mill auxiliaries have been developed, and among them is a billet bundle buster which automatically separates billets from the bundle or crane lift and moves it onto the table for charging. No manual labor of any kind is required.

The method of roughening rolls when required for dull finish has been improved by incorporating many automatic features into the shot blasting processes.

The construction of faster strip mills is largely dependent on machines which can join together the hot rolled coils. One of the latest welders that was built for a steel plant in France can join ¼-in. strip in 10 sec. Highlights of the unit are the hydraulic controls and the high speed flash trimmer. The unit is rated at 600 kva and the welding cycle is completely automatic.

A shear was built for cutting strip at speeds up to 200 fpm with an accuracy that results in all pieces being within ⅛ in. of the same length. Instead of the usual rotating cutter which required a gear change for different cut lengths, the unit has a phototube which gives the signal to the cutter motors.

Another new shear development during the year is a

downcut bloom shear which has a hydraulically operated holddown gag which automatically adjusts both itself and the stroke of the depressing table to the thickness of the slab. As a result, a clean square cut is obtained and the maintenance costs of both the depressing and shear approach tables are reduced. One unit now in operation has a 700-ton capacity and can cut 12 × 12 in. blooms at a rate of 7 cuts per minute.

A new high-speed side trimming line has been developed which will trim sheet at speeds up to 3600 fpm and keep variation of coil edges down to 1/32 in. Results are accomplished through photoelectric edge regulators, and suitable control of the trimmer motors. The control can also maintain the speed of the cutter at any preselected amount faster than the rate of travel of the strip for all strip speeds.

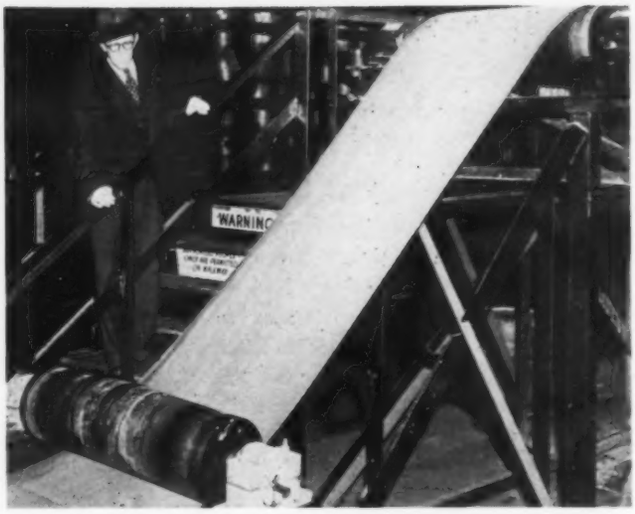
One application which will be very useful in many ways in the handling of coils and strip or anything else which may require movement over a conveyor is the self-centering roll developed by a U. S. Steel Co. engineer. This roll will have a revolutionary impact on conveyor handling of many materials. Through its design, it exerts a force which keeps moving objects in the center of the conveyor, or which will move the objects to the center of the conveyor. Thus guides and side coils may be eliminated in many cases, and edge and corner damage will be greatly reduced. The new roll is thicker at the center than at the ends, and is also cut at the center into two halves so that each half is slightly conical. The two halves rotate as a unit but are tilted with their axis at an angle so that the working surfaces are horizontal. The resulting lines of force are in the direction of the movement and towards the center of the roll. Some of these rolls are now in operation in pickling and galvanizing lines.

The new non-contact width gage for hot strip consists of a detector head in two parts which are set for the desired width of the strip, a phototube and a rotating slotted disc which provides a means of sweeping across the image of the edge of the strip at right angles to the direction of strip travel. Sideways and vertical motion have little effect on the measurement. Any deviation from the set width is shown by an indicator.

A flying sample punch has been designed which will cut samples from strip up to 0.036 in. thick at speeds up to 2000 fpm.

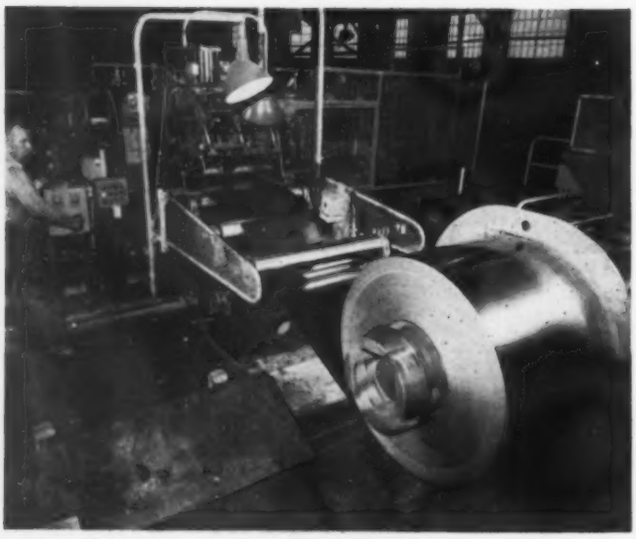
One plant which operates a Sendzimir mill has found that it can reduce roll costs very appreciably through the use of a salt bath. In present practice, the work rolls are removed from the mill and stress relieved for 2½ hr in a furnace, thus eliminating breakage and many replacements. Prior to that time, there was trouble with work hardening, surface embrittlement, spalls and breakage.

Carbide rolls are being used in a number of cold rolling applications. Speeds in operating practice follow closely that used with old rolls, and amount of reduction will run from 20 to 40 per cent. Resulting product waste is also reduced. Rolls are either of solid or sleeve type construction, the solid rolls being used for strip lighter than ½ in.



No side guides are needed on this pickling line installation at No. 18, 43-in. hot-strip mill, McDonald mills of Carnegie-Illinois Steel Corp.'s Youngstown district works. The self-aligning roll eliminates the need for guides and also makes unnecessary the guide looping of material in the pickle bath.

The entry end of a modern, high-speed, side-trimming line where steel strip is trimmed prior to tinplating operations. A photoelectric edge regulator, which can be seen at the right of the strip between the first two idler rolls, provides intelligence that shifts the entire pay-off reel assembly so that the edge of the strip is maintained at the same relative entry position.



FINISHING

Finishing capacity formed an important segment of the new facilities installed in various steel plants. Shortages in raw materials such as tin and zinc lent emphasis to the use of methods which economize such materials. There was an attempt made by the International Tin Study Group of the United Nations to set up an international tin council which would control and allocate tin supplies for the next five years. Final agreement on this has not yet been reached. Shortages in zinc supplies caused actual curtailment of finishing operations in some plants, particularly towards the end of the year.

The expansion in tin plate facilities of Jones & Laughlin means that the Pittsburgh district will maintain its edge in capacity over other regions in the

country, as about 48 per cent of the present 109,000,000 base boxes is in this district, and the program outlined for 1951 will still give Pittsburgh about 45 per cent of a total 122,000,000 boxes. The new Jones & Laughlin line will be a high speed halogen unit. It is believed that about ten electrolytic lines are being planned, some of which have already been ordered.

One possible substitute for tin may develop as a result of a process in which aluminum 0.05 in. thick can be plated on tin mill black plate with present electroplating facilities.

It is believed that, in the not too distant future, the tin plate industry will have developed its continuous methods to the point where a complete production cycle will take less than two days. The biggest factor in this time reduction is the development of a continuous annealing process and cycle. Present planning trends on such units follow, in general, a design which consists of two entry uncoilers, a seam welder, a continuous cleaning unit and entry looper, a continuous heating furnace in which the strip goes through a series of vertical loops, then a controlled cooling section where the cooling rate is rather slow, then a final cooling section where cooling proceeds at a rapid rate and from which the strip emerges at a temperature of 300 F into the air cooling zone. A controlled deoxidizing atmosphere is maintained in the heating and cooling sections to maintain a bright surface on the strip.

The fastest electrolytic tin plate line in the world went into production at the Weirton Steel Co. plant. This unit has a capacity of 5,000,000 base boxes annually, and has a speed of 2000 to 2500 fpm. Unusual feature of the line is the 1800-kw electrically heated reflow unit.

The details of the Sendzimir continuous galvanizing process were revealed during the year. In the process, surface preparation is done in two steps, first consists of oxidation of the surface being heated in an oxidizing medium or by chemical means, and second consists of reduction of the oxidized surface which is done at the same time the cold reduced material is being annealed. The second step requires the maintenance of proper quality and amount of suitable reducing gas. Rate of zinc formation is controlled by the addition of aluminum in the zinc bath and by the temperature of the base material. No flux is used in the process. The unit must normally be operated at full speed. It has a number of limitations in that it is not readily adapted for coating cut length sheets and formed articles. It is not too good a process for coating highly alloyed materials, particularly high chrome alloys. On the other hand, the production is remarkably uniform and adherent. Four lines are now in operation and another steel company was granted a license to use the process.

A 600-ft galvanizing line which went into operation in the Chicago district continuously heat treats and galvanizes cold rolled coils. This unit is capable of operating at rates up to 300 fpm and widths up to 48 in. Annual capacity is 60,000 tons. The annealing furnace is an electrical unit and the strip emerges from the furnace directly into the zinc bath.

A pipe galvanizing unit which went into operation is designed to save appreciable quantities of zinc and to increase production about 30 per cent. The unit uses four permanent magnetic pipe rolls in tandem for the dragout, and this allows two lines of pipe to be handled simultaneously from the galvanizing pot. The permanent magnets are a unique feature. The rolls run at only about one-half the speed of the previous unit which allows more excess zinc to run back into the pot.

In one of the most modern tinning lines in the Pittsburgh district, the method of adding acid to the pickler has been changed and cascade pickling is now being used. This unit consists of two proportioning flow

The new No. 4 electrolytic tin plate line of Weirton Steel Co. plates strip moving at a rate of 2500 fpm.

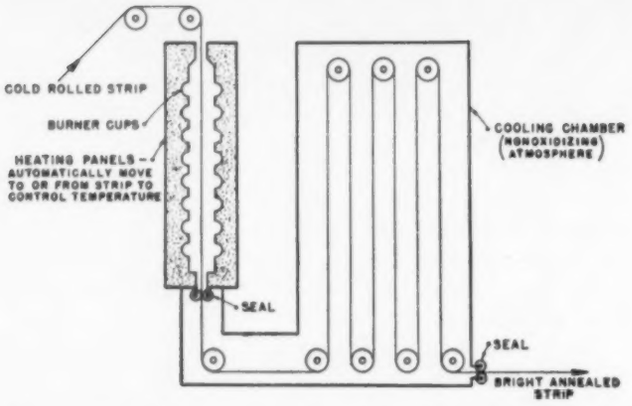


Diagram of continuous high speed strip annealing process which uses gas fired radiant panels prior to electroplating. The heating time from room temperature to 1400 F is about three sec for 0.10 in. strip and production rates up to 600 to 1200 fpm are practical.

meters, one for acid and one for water. The line first used the batch type method for seven months, and since then cascade operation has been used exclusively. As a result there is a much higher degree of uniformity and there is more flexibility in pickling different grades of steel. Faster pickling speeds can also be used. Average acid consumption is 34.8 lb per ton.

A new descaling process developed for tin plating has a descaling bath which consists of dilute sulphuric acid with a tin salt as an inhibitor. The work is made cathodic with high density current and as a result when the scale or oxide is removed, a fine layer of tin is deposited. The process has a number of advantages inasmuch as there is no etching, it gives resultant chemically clean surfaces, the tin film protects the work, conveyor handling can be used and there is no permanent embrittlement.

The phosphoric acid pickling process may become economical in competition with sulphuric acid, because a new process reclaims the acid for reuse thus cutting costs 66 per cent. Phosphoric acid pickling is preferable because of the fewer number of tanks and consequent smaller floor space, and because it is less corrosive than sulphuric acid. In the reclaiming process, the acid is pumped from the pickling tank into a hydrogen zeolite cation exchange unit. The cation resin releases the hydrogen ions, and converts the iron phosphate in the pickling solution back to phosphoric acid.

In a new process for salvaging spent pickling acid the free acid is concentrated and the iron sulphate filtered out. A semi-commercial plant has been installed which processes 50 tons of liquor a day. This plant uses a vacuum filter.

A control system was installed on a pickler which controls a depth of the strip as it moves through the tanks. One beneficial feature is that the metal is prevented from scraping on the bottom. The control comes from an electric coil in the bottom of one of the tanks which sets up a magnetic field from which the depth is measured through an electric amplifier, and this moves the strip if it is at the wrong depth.

A new tin-plate thickness gage was developed which will measure coatings as thin as 0.000001 in. in about 30 sec. The unit is an electronic development actuated by a high intensity x-ray tube with emergent radiation measured by a Geiger counter.

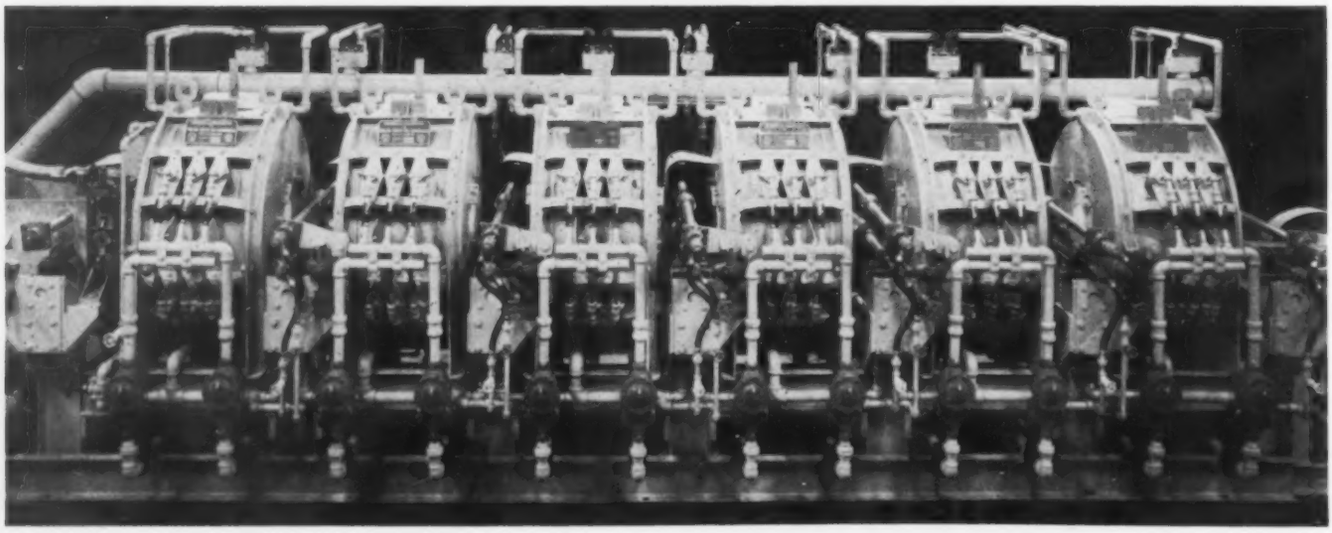
The use of strippable plastic coatings is coming into its own and has been adopted by some fabricators particularly on stainless sheets. The resulting savings in some cases has been appreciable.

At one pipe plant, brighter finishes are now being given couplings because of a new electroplating method. A nitric acid bath is used between the hot and cold rinses and the couplings are galvanized on the outside by the hot dip process. The electroplating process is used on the inside on sizes up to ½ in. The plating coats the entire thread area.

FUELS AND FURNACES

Fast heating applications have been developed and used in a number of different types of furnaces, particularly for tube applications. The use of high temperature heads has also been applied to existing equipment to overcome inadequate length of regular furnaces. In one midwest pipe plant, four horizontal cylindrical furnaces were placed in line, because the old furnace had

Equipment shown is a typical high speed radiant gas heating unit for the continuous annealing of stainless steel bars and tubes.



insufficient capacity and because adding length to the pre-heat zone meant a major capital cost. By equipping each furnace with 28 ¼-in. combustion burners, arranged in four rows of 7 each on 90 degree centers, it was found that exceptionally good heating results were accomplished. In these units, the furnace temperature is kept at 2200 F and pipe from about 8 to 13 in. in diameters with wall thicknesses of 0.3–0.5 in. is preheated up to 1200 F in periods under two minutes. The pipe being treated here is 40-ft welded tubing which is being heated before being reduced to smaller sizes. The control of such heating furnaces and their successful operation is dependent to a large degree on the radiation pyrometers which are used to both measure and control the furnaces.

Another application where radiant heat has been found very effective is in a billet heating furnace in a forge plant in central Ohio. Even though the furnace required a very small floor space, heating takes place several times as fast as in the conventional box furnace. As a result, there is relatively little heavy scale, and in turn, die life is greatly increased.

A continuous annealing furnace now under construction will use direct fired high temperature gas equipment. It will operate at 600 fpm, and its production in four hours will be as much as obtained in 100 hours from a batch type furnace. One of the beneficial effects of this short time continuous process is that the heating time is so short that no oxidation occurs, and subsequent cooling in a prepared atmosphere gives a bright annealed steel. One interesting point, in such fast heating times, which in some cases are in the order of three seconds, is that the steel may have different physical characteristics than when processed with the usual heating cycle. Thus, such short cycle methods offer possibilities for developing new properties in the steel.

Some continuous tin-plate annealing lines under construction are designed to operate at rates as high as 1000 fpm which will be approximately 30 tons per hour. Heating is accomplished in some of these units by all gas, and some by all electric and some by a combination of both. The electrical equipment is even more complicated than that used on rolling mills, and a typical annealing line may have 82 d-c motors totaling 835 hp in an adjustable voltage system of 725 kw. In addition, 54 auxiliary a-c motors totaling 650 hp are required.

In order to obtain the right type of tin-plate product, it is becoming more and more evident that the annealing atmosphere is of extreme importance in the properties of the final material. The most widely used atmosphere is deox gas, but both lean gas and nitrogen-hydrogen gas are finding increasing use. This is an extremely important problem, inasmuch as over 5,000,000 tons of products are being annealed at the present time.

Some of the difficulties normally found in conventional RF heating of non-magnetic strip are being overcome by transverse induction heating. Two 300-kw pilot line installations are being tested at the present time.

In an unusual type heating furnace, a walking beam is used to lift parts from the stationary rails and advance the whole furnace load a fixed distance. Such a design is being used in a heat treating furnace operating at 2000 F.

A new galvanizing furnace eliminates the dross which forms from the reaction of the container with the molten zinc bath. This furnace uses low frequency electric induction heat in a refractory lined furnace which does not react with the bath. Contamination from the pot is thus eliminated. It was estimated that electric power consumption is approximately 100 kwhr per ton of galvanized steel.

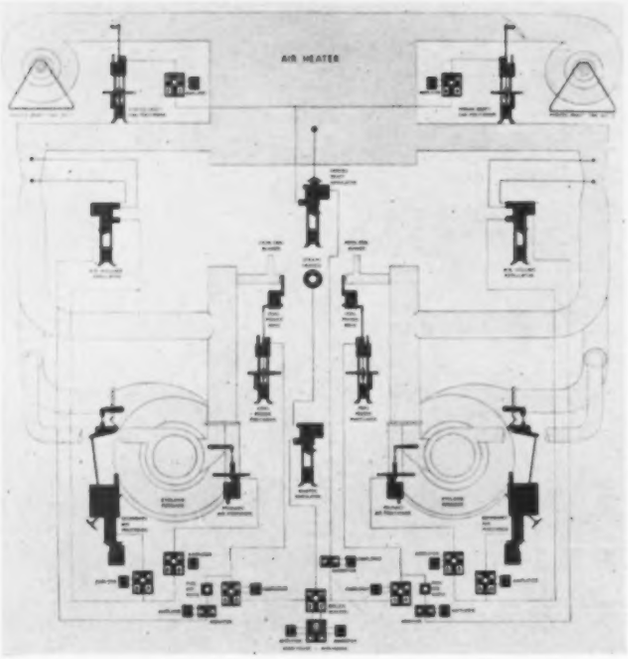
This multi-baffle furnace has averaged better than 65 tons per hr.

A form of electric heating uses carbon electrodes submerged in molten glass. The principle basically involves obtaining heat radiation from the molten glass bath through which the current is passed. The chief advantage is that high temperatures up to 2700 F can be readily obtained, for heating either small pieces or large ingots of 50 tons or more. It is claimed that the unit gives very efficient heating, uniform temperature and the temperature can also be closely regulated. It is also possible to maintain a controlled atmosphere which cannot be easily done in other large high temperature furnaces. The shape and size of these units will be dependent on the product to be heated.

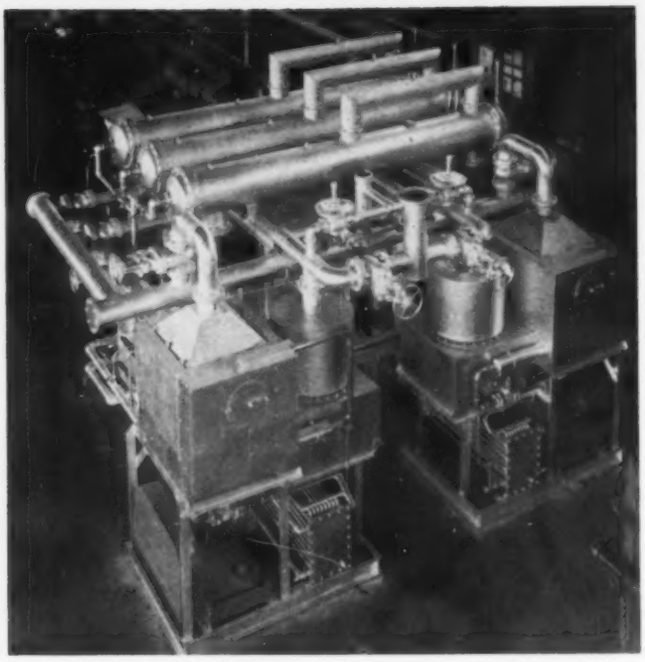
A development in skid pipe insulation for continuous furnaces offers a simple way of reducing heat losses, increasing production and improving the fuel rates. The insulation is a high grade refractory material which is precast in convenient lengths and reinforced with alloy steel mesh. The material is made in two halves, and the sections are permanently fastened in place by welding the exposed ends of the mesh to the pipe. The normal pipe surface of a 300 sq ft-furnace can be covered in less than 14 hours. This insulation when applied to water cooled skid pipes, to risers and crossovers reduces the heat loss to the cooling water by as much as 82 per cent. This large reduction is effected because the heat is lost in the high temperature area of the furnace where the temperature may be as high as 2400 F. In addition, the steel is heated more uniformly, skid marks are essentially eliminated and there is less slag.

One innovation in furnace lining practice is the use of alternate courses of silica and basic brick in areas subject to wear such as roofs and back walls. It has been found that the life of such areas is increased and the method is being tried by several companies.

The radiation pyrometer has been adapted to measur-



Greater accuracy and faster speed of response with elimination of transmission lags are some of the advantages of this new control system.



The DX generator shown has a capacity of 35,000 cfhr for use in steel plants.

ing the temperature of tin-plate as it moves on the continuous coating lines.

A major advancement in the field of automatic control is an electronically operated master control system which may be used for combustion and process control application. Advantages claimed for the setup are greater accuracy, and speed, elimination of transmission lags, simpler and smaller control panels and complete freedom of control centralization. The unit combines the null-balance principle of detection, and electronic transmission of control information. The result is a highly responsive system which operates quickly regardless of the distances involved. It is also easy to switch from manual to automatic operation. No piping is required and multi-wire cables are the only connection between the control bench board and the individual measuring and control elements. The electronic link connects the control elements to the master by a circuit similar to an a-c Wheatstone bridge. This link consists essentially of two voltage dividers or slide wires connected through an amplifier. The sender slide wire is mounted on the master element, the receiving slide wire (which forms the other two legs of the bridge) is mounted on the actuator, and controls the position of the final regulating unit such as a damper or valve. The position contactor on the receiving wire is driven to follow and repeat with precision the position of the contactor on the sending wire. In other words, the final regulating element will assume the exact position dictated by the master.

Of interest to the fuel engineer is the fluid energy pulverizer which gets its energy for pulverization from superheated steam or air. The reduction in the particle sizes is obtained by high velocity impingement of particle against particle. Inasmuch as the materials grind against themselves rather than against any portion of the mill, maintenance and wear is reduced. The pulverizer is particularly applicable for the pulverization of any grade of solid fuel regardless of moisture content and grindability factor.

The government has continued with its development work on obtaining synthesis gas from coal. Although much more work remains to be done before definite conclusions can be made, present opinion favors gasification of powdered coal in the entrained state in suspension with oxygen or steam. It is believed that these processes can be applied to all types of domestic coals. High reaction temperatures are favored to maintain a good gasification efficiency and to keep formation of methane at a minimum. Coals should have low ash-fusion points so that the ash may be withdrawn as a molten slag. Based on present cost estimates and with present oxygen prices, it is believed that synthesis gas can be made at about 15 cents per thousand cu ft, if the coal costs $2 a ton.

The work of the Bureau of Mines on synthetic fuels indicate that their costs are nearing competitive levels. Refined products now can be produced from oil-shale and coal with costs averaging 7.3 and 10.8 cents a gallon. Further improvements will lower these costs, and with the increasing rise in other fuel prices the balance may be struck sooner than formerly thought. Capital investment now required for a 10,000 bbl-a-day plant is estimated at about $4000 for each daily barrel of crude oil capacity, or $4700 per daily barrel of finished product. Since the oil-shale area of western Colorado is sparsely populated, the market is not available locally. Estimated capital investment for a coal-hydrogenation producing 30,000 barrels a day is estimated at $8200 for each daily-barrel of product capacity.

Developments in mechanized mining in the ore-shale mines have lowered mining costs to 29 cents per ton of shale.

The realization that materials handling costs are such a major part of steelmaking has resulted in a great deal of thought and planning to minimize these factors in new installations, as well as in existing plants. Such planning has resulted in increased use of palletization, and increased use of conveyors. The latter method has been used in various ways and as a component part of almost every type or piece of continuous machinery and equipment.

One of the most radical developments is the elevator in the open hearth shop of Armco Steel, described in greater detail under Steelmaking.

Conveyors are of very many different types. The belt conveyor is becoming the standard piece of equipment for handling ores at the mine; conveyors will also do the major portion of the bulk handling in ore processing and beneficiating operations. Speeds have been increased, and belts now operate up to 1250 fpm. Coal mines are using belt conveyors with very appreciable savings in the cost of handling coal at the mine.

The proposal which was made a year ago to build a two way 130 mile railroad between the Ohio River and Lake Erie was abandoned for the time being, because approval was not forthcoming from the Ohio state legislature. It is believed, however, that another attempt will be made to attain this at the present session.

Life of conveyor belts is being continuously increased and some of the factors in this increased life are newer and stronger fabrics, and cords, and the introduction of steel cable cord reinforcements. Belts are now made 3 to 4 miles long and lifts up to 1000 ft have been used. One of the newest belts is estimated to be able to carry 2000 tons an hour at 500 fpm for a distance of one-half mile up an 18 degree incline. Such belts are, however, quite expensive.

Another interesting conveyor application was the replacement of a six mile underground railroad operated by a coal company with a belt conveyor system. This moves over 1800 tons of coal an hour from the work facings through a mountain to the barges waiting on the Monongahela River. Another unusual application is a conveyor installation in a coal mine some 300 ft under the bed of the Pacific Ocean off the coast of southern Chile. Here a 4700-ft belt hauls the coal back up on the shore.

The portable conveyor with an air motor drive is very effectively used in many steel plant applications.

Belts are used extensively in steel and coke plant installations, some of which transport the coal from the barges to the river and also reverse themselves and carry back the finished coke.

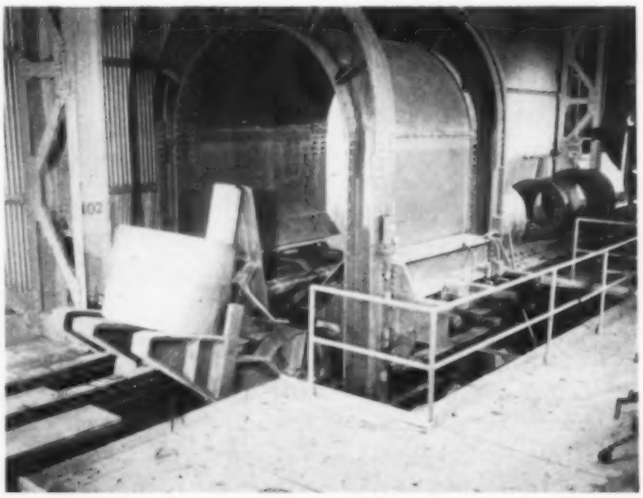
Conveyors are used at one steel company to haul hot steel strip while the material is enroute to the stockhouse. The unit is a 960-ft overhead conveyor which travels at 5 to 15 fpm, dips down to the loading position at the coiler and transfer carriage, and then rises 17½ ft to pass across one end of the mill building and over a driveway.

Two way radios are being used on fork trucks and have been found economical, because they eliminate wasted time and reduce travel without pay loads.

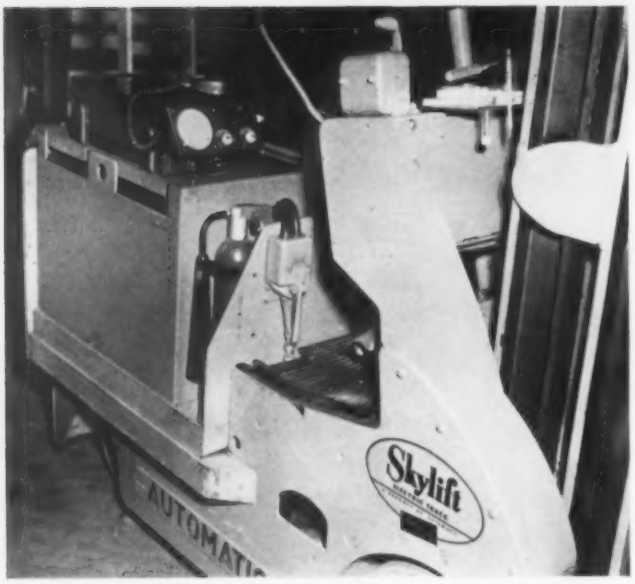
Crane design progressed during the year and the result was larger, faster and more dependable equipment. Strippers attained a new high in capacity and five 400-ton units were shipped by one company during the year. Plans are also being considered for a 400-ton ladle crane, a trend which will continue with the larger open hearths now being built. Also under construction are pit cranes of 30-ton capacity.

For small shops, a 250-ton portable ingot stripper

This unit will transfer coils between conveyors on the same center line, at the same time tilting them on their sides.



Straddle trucks are effective carriers for many types of steel plant products.



Two-way radio sets on fork trucks are the latest wrinkle devised by materials handling engineers to cut costs. Wasted time and travel without loads are slashed by up-to-date communications.

has been designed which can be suspended from the hook of regular service crane. This gives flexibility to the operation of such units and enables the service crane to perform two functions. The unit is hydraulic, and the action of the ram is remotely controlled from the crane operator's pulpit. The unit has a maximum stroke of 18½ in. One is in use in an electric furnace shop which is producing about 425,000 tons annually.

A 125-ton, single leg gantry crane which serves the bessemer converters of National Tube's Lorain, Ohio works is the largest unit of its type which has ever been built. This crane is unusual inasmuch as the shafts have been eliminated from the bridge drive by designing the crane with box section type legs. Enough rigidity is present to allow the successful operation of the individual motor bridge drives. No provision was made to synchronize the motors electrically.

The largest ore carrying ship ever planned is to be built for the National Steel Corp. It will be able to transport 21,000 gross tons, and will be launched in the summer of 1951.

The trackmobile, a gasoline powered unit, can take the place of the shifter locomotive for some applications.

MECHANICAL DEVELOPMENTS

This country is in the midst of the greatest expansion in the history of the power industry. Electric generating capacity has increased by a third since the end of the war and in the next five years there will be a further increase of about 40 per cent. To meet this expansion more efficient and larger power units are on the production line. Reheat units are back in the picture, the largest one under construction having a 125,000-kw capacity. The size of generating units is increasing and recently one machine was considered which had a capacity of 150,000 kw with 0.5 psi hydrogen pressure.

An analysis of the central station steam tubines of 10,000 kw capacity and larger which have been shipped from one large manufacturer in the last year showed that over 28 per cent of the kw capacity was for 951 to 1050 F temperature and 43 per cent was for 1251 psi pressure or greater including 12 per cent for pressures of 1451 to 2000 psi. Resuperheat accounted for 26.6 total kw capacity during the year.

At the present time, maximum steam conditions for turbines have leveled off at 1050 F and 1800 psi.

A new reheat type steam turbine recently put into service admits the initial and reheated steam in the middle of a single double-flow high pressure casing thus avoiding the high temperature gradient formerly met in single-casing reheat units.

What is said to be the most efficient power plant of its size in the world was opened during the year at Portsmouth, N. H. This unit is a 40,000 kw station which combines the use of mercury vapor and steam driven turbine generator. It is said that it will be able to produce more electricity for a given amount of fuel than any other equipment yet built. This plant uses 9200 Btu per net kwhr, when bunker C fuel oil is used, and 9420 Btu per kwhr when coal is used.

As a result of increased turbine efficiency, the drop in the amount of fuel required to produce the kwhr of electricity has gone from 6.6 lb in 1900 to 1.3 lb at the present time.

In the Chicago district, one of the steel plants installed a 60,000-kw steam tubine. This unit will use by-product gas for the production of power.

Unit installations are being used more in power plants, whereby a single turbine generator is connected to a single complete steam generating plant. This principle is also expanded, so that no interconnections are provided between units in multiple installations. The results are substantial savings in investment maintenance and operating costs.

The modern steam plants are using centralized control, and because of the almost completely automatic characteristics, the plants are developing into push button units.

The advantages of centralized control for steam power station come from: (1) reduction in operating personnel, (2) since all data is in front of one operator the plant can be better operated as an integrated unit, (3) operator may control several operations simultaneously, (4) errors in communication are avoided. Disadvantages of centralized control are: (1) additional space for control room, (2) additional control equipment, (3) more complex equipment, (4) increased cost because of control duplication or longer runs.

Cooling towers are being used to a greater degree than previously, particularly because of difficulties in obtaining cooling water. Losses in modern cooling systems run about 3 per cent more than those in the normal system.

Power plant engineers are finding that inhibited phosphoric acid will remove rust and scale from new boilers and water-formed insoluble deposits from boilers in service. The advantage of phosphoric acid over hydrocloric acid is the former can be boiled in the unit with little attack of the metal. Its stability is also an advantage. A 5 per cent solution gives good results.

Boiler scale is being eliminated by the use of ultrasonic vibrations in the boiler water. One unit which has been installed has an oscillator which vibrates at about 2700 cps. The apparatus is simple in design and should be economical.

Attempts are also being made to adapt gas turbine techniques to the generation of steam power. Most gas turbine cycles are more efficient than steam in the upper temperature range and less efficient in the lower temperature range. One possibility is a combination gas turbine cycle with external combustion which uses ordinary gas turbine and steam turbine components in such a manner that the thermo-dynamic advantages of each in their respective temperature ranges are combined to give a higher thermal efficiency than either steam or gas alone.

The development work on the coal fired gas turbine is practically completed and it appears that this unit is now ready to compete economically with any prime mover in the power field. Apparently the fine dust which adheres to the turbine blades has relatively little effect on turbine performance.

A number of commercial gas turbines are being constructed. These fall into three types; one a 3500-kw simple cycle, the second a 5000-kw two shaft compound cycle for power generation, and the third and latest a 5000-hp two shaft mechanical drive type for gas line pumping and other operations.

In Alabama, a gas turbine has been successfully operated on the gases formed from burning coal underground in the mine.

The old argument as to which inert gas is better for shielded welding, argon or helium, has now resolved itself into the application to be welded. Helium gives higher heat, deeper penetration and faster speeds. Argon needs less heat, gives little spatter and gives smoother operation. A new development for special cases, involves mixing the gases to give the most desirable arc characteristics.

It is claimed that a way has been developed to braze high temperature alloys, such as those used in gas turbines. Physical properties are as good as base metal and strong enough for 2000 F service.

Advancements in cold welding involve a supplementary technique called trap welding. This technique permits welding of inserts into similar or dissimilar nonferrous metal.

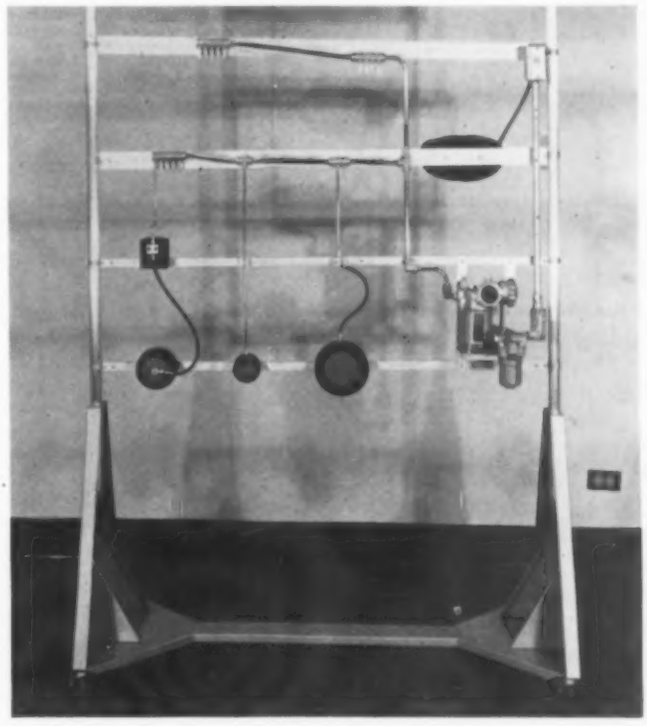
Welding control equipment is being improved and one of the latest features incorporates touch-and-weld starting. In this method the electrode is touched to the work and withdrawn to start the arc. In a second starting method, the cycle is initiated by a switch and this is particularly useful in repetitive operations where contact of the hot tungsten is undesirable.

A new pressure gun for spraying powdered metals uses an air blast which forces the powder into the nozzle which is somewhat different from present vacuum type guns. Higher coating densities are claimed.

A new metal forming process was announced during the year. This process combines the best features of rubber press forming and steel die drawing, and enables the manufacturer to make deeper draws with lower tool costs. A wide variety of products can be economically furnished by the method. Production savings as high as 50 per cent are being made.

One trend in the application of lubricants is the standardization of different types in order to simplify purchases. Through such work one nonferrous metal producer estimates that it has accomplished savings up to $1,000,000 a year.

Equipment applications in high temperature areas create a problem in bearing lubrication. One motor operating in an area where 1500 F gases are present



Component parts of an oil-mist automatic lubricating system are shown in this figure.

was designed to operate successfully with a prelubricated sealed ball bearing, through the use of a low thermal conductivity shaft and a heat exchanger which removed the heat from the shaft.

Because of the successful operation of silicone lubricants at high temperatures, a drawing furnace is being built in which the conveyor will move through the furnace instead of outside, even though the temperature is 700 F. Experience indicates that the lubricant can be used up to 700 F for loads as high as 400 psi.

The development of the oil mist lubricating technique in which oil is delivered to all types of machine bearings in the form of air-borne microscopic particles is resulting in reduced consumption of lubricant, and prolonged bearing life, as well as lower bearing temperatures. Spoilage is also being reduced because of elimination of drippage. The heart of the system is the lubricator

which atomizes the lubricating oil by means of compressed air.

The use of alumina as a filler in plastic bearings adds strength and wearing qualities. In roll neck bearings, the material has given a production of 65,000 tons of strip steel per bearing compared with 10,000-ton life of fiber-filled bearings.

One interesting development in plant clothing is a chemical which will flameproof cloth. As a result, it is being widely used in some steel plants on mill clothing. Material resists flame even when liquid hot metal at 2800 F is spilt on the flameproofed cloth.

Orlon, a new industrial fiber, offers many possibilities because of its resistance to acids, solvents, oils and greases. Production plants for this material are now under construction.

A material which was developed during the year is one which remains liquid as long as a stream of air bubbles through it, but which hardens in a few minutes when away from air. It thus behaves in a manner opposite that of paint. The material, therefore, can be used to seal cracks and leaks and as pipe dope. It is called anaerobic permafil.

A multiple alloy plate steel developed during the year combines high strength with excellent ductility and toughness, even at sub-zero temperatures. The material is several times more resistant to atmospheric corrosion than carbon steels, and about three times as strong as ordinary structural steels. The desirable properties are a result of blending multiple alloying elements with precision heat treatment. By restricting the carbon to 0.18 per cent material can easily be welded and cut.

The nodular irons are finding many applications. Their possibilities in making gears have just been touched. One company made a 12-ton blast furnace slag pot out of nodular iron. This has been in use for almost a year with practically no sign of cracking or warping. Ductile irons are also being annealed in some cases in order to obtain better machinability. This is also being done with little effect on desirable properties. Fatigue tests on nodular irons have shown that the material has higher fatigue than the flake graphite irons, but stress raisers have a greater weakening effect on the nodular iron.

Experiments have been made in Europe in which cast iron billets are hot rolled in a mill. Ultimate tensile strength values as high as 144,000 psi are claimed.

Dye penetrants have been developed which quickly reveal surface flaws in materials. The method is much more economical than the x-ray and similar types of inspection. In the method the penetrant is applied, the excess washed off, and a developer is then applied which brings out the cracks. Through the use of the method, flaws can be determined before the part is completely machined, thus eliminating machining costs on a part which would later be rejected.

Ultrasonic inspection of materials such as shafts, etc., for cracks found increasing application during the year.

A new detector for picking up tramp metal in such operations as crushing and grinding of ore has been developed which will eliminate such pieces whether they are magnetic or nonmagnetic. One such unit is already in operation.

The steel sorter is a unit developed during the year which will differentiate between all types of carbon steel because of magnetic differences in the metal. Through its use material can be rapidly sorted in the steel plant.

The Geiger counter has also been used in steel plant operations in conjunction with spectrographic equipment to determine the kind and quality of alloying elements in steel. The steel need not be radio-active, as the counter has the ability to measure fluorescent rays which emanate from steel samples when the atoms are ionized by x-rays. An intense x-ray source is required.

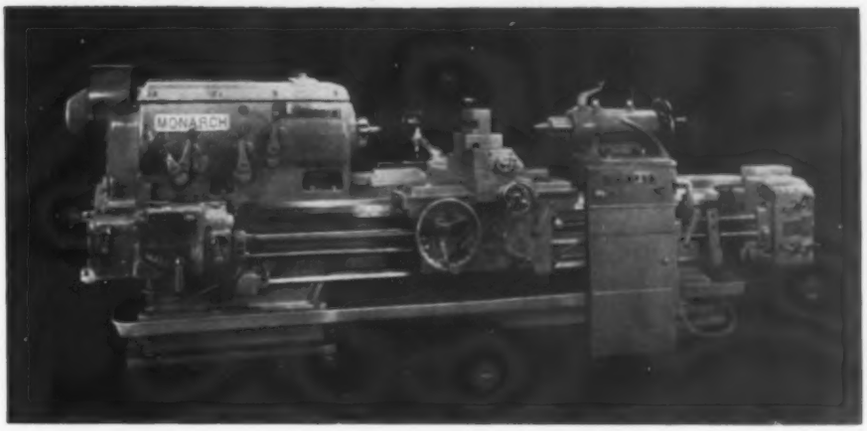
A metals comparator has been developed which inspects and classifies metals. It can be used for control of combustion heat treatment, hardness, case depth and plating thickness. Many possible applications are practical, and many special problems can be solved through the use of the unit which is basically an impedance comparator.

The automatic computators which have been so widely used for gunfire control have been brought into the machine shop and developments are under way which will set up automatic machining. In one application, the data from the blueprint is punched on a paper roll similar to that on a player piano, and this is then fed into the control equipment which operates the lathe or other machine tool which is making the piece. As a result one machine operator can tend a number of machines.

A roll lathe which was developed in Europe is to be manufactured in this country. It will remove metal at rates up to one ton per hour, and will handle rolls up to 30 in. diameter and 33 ft long. Machine is adaptable to contour turning and automatic chip removal.

Machine tools are operated at ever increasing speeds and some units under test are going at 20 times the speed of sound, with spindle speeds of some grinding machines now being tested greater than 2000 rpm or 16,660 mph such speeds result in efficient grinding and very close tolerances.

The flameproofed trousers shown in this unretouched picture were subjected to several severe washings with the most caustic materials, and then completely dried before the test was made.



This lathe was designed for contour turning of mill rolls up to 15 in. in diameter and gives substantial economies to this type of work.

One interesting development in lathes is a unit which has a T-shaped bed. The machine can handle facing as well as straight or tapered turning or boring. It is, of course, designed for precise work on relatively large diameter, short, thin-walled sections. Its greatest advantages are its reduced floor space requirements and its lesser initial costs.

In machine operations it has been found more effective, particularly for some alloys, to preheat material to about 1500 F and then machine it while hot. Metal removal has increased as much as three to 134 times that for machining material when cold. The theory is that the increased efficiency is due to the elimination of heat dissipation of the heat generated by friction.

Another novel machine development is curvilineal machining on planers and shapers. These units have normally been limited to straight line generation. New tracer control planing through a hydraulic tracer mechanism makes possible what might be called three dimensional machining.

A newly developed portable hydraulic shear is capable of handling rod up to 1$\frac{1}{16}$ in. diameter. It is very light as the cutting head weighs only 38 lb, and is operated by a flexible hose from a semi-portable pump. The unit is particularly valuable in rod mills, and can perform many specialized cutting, punching riveting and blasting operations.

For blast cleaning metals and for cleaning of electrical equipment, soft grits have provided a low cost method. Corn cob grits, rice and nut shells are used for degreasing scale removal and cleaning. This will provide the maintenance man with a new tool, once he has developed the proper operating techniques.

Television cameras are being applied in industrial control applications. Most industrial units are wired thus requiring no channel allocations. The chief use is to enable operators to watch boiler water level indicators, level of molten metal where constant pouring rates are required as in continuous casting, and also in smoke control. One of the latest developments in television control is the use of a stereo system which uses a pair of cameras in one unit, thus giving a three dimensional image.

ELECTRICAL DEVELOPMENTS

Apparently enough electrical power is available to meet any requirements in the United States. Undoubtedly there will be local shortages, and the utility companies have expansion programs at most of these spots, although in some cases demands are increasing faster than planned capacity expansions. The industry's present expansion program will increase capacity from 65,600,000 kw in 1950 to 86,000,000 kw in 1953. The peak load for 1950 is estimated at 58,700,000 kw and that for 1953 at 71,700,000 kw. Industry is using about 55 per cent of the total electrical power produced in the United States, and about 77 per cent of this is used by motors, the balance going to electric furnaces, electrochemical applications and lighting. Total power consumption in the United States in 1950 was estimated at 279,700,000,000 kwhr which is about 12 per cent over that used in 1949.

Capacity of switchgear is becoming larger, and one system is being designed for 7,500,000 kva on a 161-kv system. Improvements in the interrupters enable high capacity and medium voltage breakers to interrupt in three cycles instead of five and they can be reclosed in 15 cycles instead of 20 or 30.

Compressed air breakers were built for operation during the year for 69 kv. These are the first in the country for voltages above 34.5 kv, they carry 2000 amps and have 3,500,000 kva interrupting capacity. Other new compressed air breakers of smaller capacity have been designed which have the advantage of occupying less space. One of the big factors in improving circuit interruptions has been the schemes which reduce arcing time. The development of a new arc chute has reduced this period.

Maximum interrupting capacity of steel tank oil circuit breakers, now being built, is 10,000,000 kva. They are rated at 230 kv.

A low voltage cartridge fuse has been developed for 600-v and below which will safely interrupt high short circuit currents up to 100,000 amp a-c or d-c. They may be used in standard fuse holders.

An ingenious by-pass switch was installed on a 15,000 kva capacitor which has the novel feature that it does not take the capacitor out of the circuit during the critical fault periods, even though it protects the unit. It simply provides a by-pass for the excess current the capacitor cannot handle. The excess current goes through a special resistor which is in parallel, and this is removed when the current drops by a jet of air which is blown across the gap forcing arc extinction on each current zero.

A low cost light weight oil switch was developed during the year which makes economically possible, installation of a large number of capacitors and their switches on a single pole wherever desired. This switch is a single pole contactor that resembles a recloser.

In the transformer line, liquid filled units are on the way out for industrial plants and are being replaced with air and gas cooled units. A completely sealed dry type transformer makes possible the elimination of transformer liquids in subways and vaults and in contaminated atmospheres.

A method has been developed to stop the load tap changer of a transformer precisely and quickly. This is done by reconnecting the windings of the single phase, split phase capacitor motor in such a way that there is no reversing torque after the motor has stopped. Stops are thus accomplished in about six revolutions or six cycles with no hunting.

One detail in electrical equipment which should reduce future maintenance has been the development of cold welding to join electrical parts. Items such as electrical contacts which are riveted or soldered to copper or brass bars ordinarily become loose with time. With cold welding the piece is permanently fastened. Another detail where the method is of value is the welding of copper wire to the copper-clad steel rods such as are used for grounding. Many other applications should be developed in the future.

Tests were made on laminated magnet frames on generators for reversing, blooming and slabbing mill service. These tests indicated that in the majority of cases, satisfactory results can be obtained from solid frames if proper attention was paid to design characteristics. In some cases, however, laminated frames may be utilized in addition to a large number of magnetic poles for very high speed performance.

Several existing steam-driven mills were rebuilt to use electric drive. On one Canadian unit, a 7000-hp, 50/120-rpm unit is being installed with a single armature pinion stand drive, whose current is furnished by a flywheel motor generator set with two 3000-kw generators.

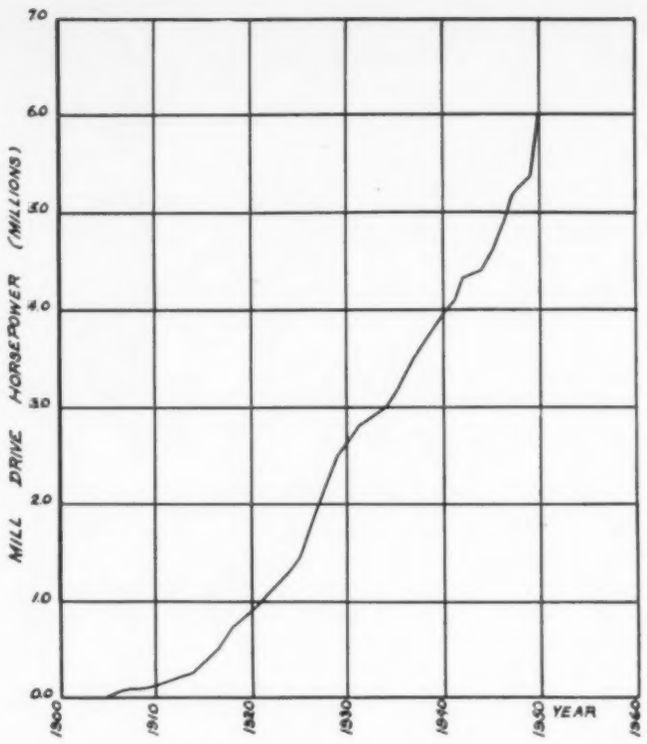
The world's largest plate mill was electrified during the year and this 206 in. mill is now being driven by one of the largest twin drives ever manufactured, an 8000-hp, 30/75-rpm twin motor whose power is furnished by a flywheel motor generator for four 1750-kw generators.

One of the largest reversing cold strip mills ever built is going to Belgium. It is a combination sheet and strip mill with a 3000 hp main drive and two 1000 hp reel drives.

Rotating regulator control on reversing mills is becoming standard practice. Reversal times are reduced and on one mill which went into service during the year, the reversal time is 1.2 sec from base speed to base speed. This is a 40 in. blooming mill with a 6000 hp 40/100 rpm twin drive.

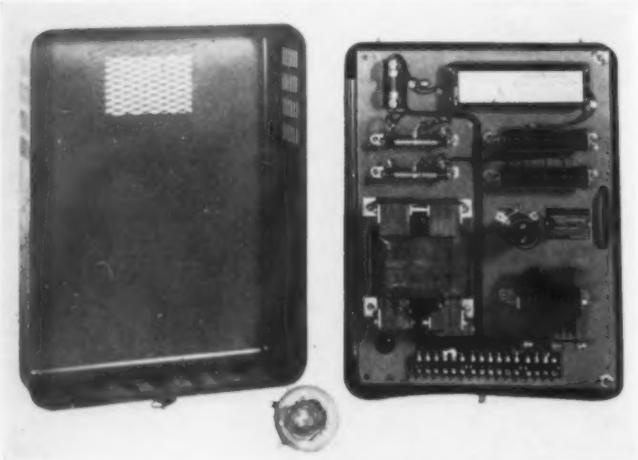
The individual generator control system was the choice on all modern high speed mills. At the same time ohmic-drop control used in conjunction with the individual generator schemes was acceptable for present and future mills.

The marked expansion in steel operating equipment was reflected in the mill drives which were ordered during the year. Total horsepower sold by the electric motor manufacturers for mill drives during the year surpassed by a wide margin the corresponding data for any other year in the past. This large amount was also partially due to the desire of the purchasers to get well up on the order list, and thus may reflect some demand which might ordinarily have shown up on next year's list. The total number of motors ordered were 268, of which 32 were a-c.



The cumulative curve of main drive motors over 300 hp shows a total to January 1, 1951 of 5,988,890 hp. Two hundred sixty-eight motors (529,200 hp) were added in 1950, a new record for any year.

The static magnetic amplifier is coming into its own. Illustration shows packaged voltage regulator system which was built for a high frequency generator.



New insulation materials in mill motors, particularly those designed for high temperature service, are reducing downtime and maintenance costs. A fiber glass tubing for coil leads is one factor in such improvement. Plastic coated sleeving reduce failures which occur when the tubing is held in the bent position for long periods. Longer motor life is also the result of a fiber glass reinforced polyester laminate which is used for such items as middle sticks, slot wedges, armature end laminations, collars and coil washers. In addition varnish coating of motor windings increases dielectric strength and resistance of coils to moisture.

Instrument transformers have been particularly improved through the use of molded butyl rubber around the coils instead of the conventional insulation of asphalt impregnated type. The one piece molded construction gives great resistance to shock. Hook-on instruments have been developed, and one of the outstanding features of the hook-on volts-ammeter is its ability to measure load currents without disconnecting power leads. This is done by a built-in, split-core transformer which clamps around the conductor. A hook-on wattmeter has also been developed which provides six power ranges up to 300 kv and voltages up to 600 v. The principle of the hook-on meter is that the electrical quantity is measured by obtaining the effect of the magnetomotive force which is a unique function of the current, and provides a magnetic flux for a secondary winding or an instrument mechanism.

A new regulating device called the microsyn which was developed in the instrumentation laboratories of Massachusetts Institute of Technology, provides regulation in infinitesimal steps. It is more sensitive and accurate than devices of the selsyn type. These microsyns can produce a voltage proportional to turning a rotor over a range of plus or minus of 10 degrees with a sensitivity of 20 sec. It can produce a torque that is linear with the square of a signal current, and can act as an elastic restraint generator producing a torque proportional to the product of the square of the current and the angular displacement.

Selenium rectifier power packs are now being applied to provide the high d-c potential which is needed for electrical precipitators, thus eliminating the high maintenance, and low efficiency problems which accompany the use of the old rotating spark gaps. Such selenium power packs are available for voltages up to 100 kv.

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1950

Item	Horsepower	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
1	①150 ②	250/650	650	d-c	Direct	48 in., 2-stand temper mill	Granite City Steel	Granite City, Ill.	Allis-Chalmers
2	300	300/555	250	d-c	Direct	Temper pass mill	SOLLAC	France	Westinghouse
3	300	300/555	250	d-c	Direct	Temper pass mill	SOLLAC	France	Westinghouse
4	300	600/1200	250	d-c	Geared	Cold brass mill	Chase Copper & Brass Co.	Waterville, Conn.	Westinghouse
5	300	285/400	600	d-c	Direct	Temper pass mill	Kaiser Steel Corp.	Fontana, Calif.	Westinghouse
6	300	285/400	600	d-c	Direct	Temper pass mill	Kaiser Steel Corp.	Fontana, Calif.	Westinghouse
7	300	225/1000	600	d-c	Direct	Temper pass mill	Kaiser Steel Corp.	Fontana, Calif.	Westinghouse
8	300	175/650	300	d-c	Direct	Temper pass mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
9	300	175/650	300	d-c	Direct	Temper pass mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
10	300	400/1200	600	d-c	Geared	Reversing cold strip mill reel	Thompson Wire Co.	Franklin Park, Ill.	General Electric
11	300	400/1200	600	d-c	Geared	Reversing cold strip mill reel	Thompson Wire Co.	Franklin Park, Ill.	General Electric
12	300	*514	2300	a-c	Geared	3-High roughing mill for rod	United Engineering & Foundry Co.		General Electric
13	300	850/1500	600	d-c	Direct	Temper mill entry puller	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
14	300	300/1200	600	d-c	Geared	Temper mill pay-off reel	Breedband, N. V.	Ijmuiden, Holland	General Electric
15	300	250/1000	540	d-c	Geared	Temper mill pay-off reel	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
16	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Detroit, Mich.	Elliott
17	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Detroit, Mich.	Elliott
18	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Rome, N. Y.	Elliott
19	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Rome, N. Y.	Elliott
20	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Rome, N. Y.	Elliott
21	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Rome, N. Y.	Elliott
22	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Chicago, Ill.	Elliott
23	300	450/900	250	d-c	Geared	Main mill drive for 6-in.-28-in. x 30-in. reversing brass mill	Revere Copper & Brass Co.	Chicago, Ill.	Elliott
24	①300	250/650	650	d-c	Direct	48-in., 2-stand temper mill	Granite City Steel Co.	Granite City, Ill.	Allis-Chalmers
25	①②300	575/750	600	d-c	Direct	2-Stand temper mill, No. 1 stand	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
26	①②300	575/750	600	d-c	Direct	2-Stand temper mill, No. 1 stand	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
27	350	400/800	230	d-c	Geared	Hot strip mill edger	Armco Steel Corp.	Ashland, Ky.	Westinghouse
28	350	400/1200	250	d-c	Geared	Cold mill	Dow Chemical Co.	Midland, Mich.	Westinghouse
29	400	600/1200	250	d-c	Geared	Cold brass mill	Chase Copper & Brass Co.	Cleveland, Ohio	Westinghouse
30	400	600/1200	250	d-c	Geared	Cold brass mill	Chase Copper & Brass Co.	Waterville, Conn.	Westinghouse
31	400	300/600	600	d-c	Direct	Reversing cold strip mill	Fiat Co.	Turin, Italy	Westinghouse
32	400	500/1000	250	d-c	Direct	Temper pass mill	SOLLAC	France	Westinghouse
33	400	400/800	250	d-c	Geared	Temper pass mill	Crucible Steel Co.	Midland, Pa.	Westinghouse
34	400	400	2300	a-c	Geared	Finishing mill for rod	United Engineering & Foundry Co.		General Electric
35	400	400/800	250	d-c	Geared	Temper mill tension puller	Breedband, N. V.	Ijmuiden, Holland	General Electric
36	400	500/1250	250	d-c	Geared	Brass mill	Bristol Brass Corp.	Bristol, Conn.	General Electric
37	①400	400/600	600	d-c	Direct	Temper mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
38	①400	400/600	600	d-c	Direct	Temper mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
39	400	300/900	600	d-c	Geared	Continuous rod mill	Continental Steel Corp.	Kokomo, Ind.	Allis-Chalmers
40	①②400	575/750	600	d-c	Direct	2-Stand temper mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
41	①②400	575/750	600	d-c	Direct	2-Stand temper mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
42	①②400	425/550	600	d-c	Direct	2-Stand temper mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
43	①②400	425/550	600	d-c	Direct	2-Stand temper mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
44	②400	300/1200	600	d-c	Direct	2-Stand temper mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers

*Indicates synchronous motor †Indicates induction motor ①Twin motor drive ②Double armature ③Triple armature

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

(CONTINUED)

Item	Horse-power	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
45	450	150/600	600	d-c	Direct	Skin pass mill reel	S.I.A.C.	Cornigliano, Italy	General Electric
46	500	277	‡2300	a-c	Geared	2-High intermediate mill for rod	United Engineering & Foundry Co.		General Electric
47	500	150/600	600	d-c	Direct	Hot strip scale breaker	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
48	500	500/870	600	d-c	Geared	Temper mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
49	500	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
50	500	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
51	500	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
52	500	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
53	500	300/600	600	d-c	Direct	Skin pass mill	SOLLAC	France	Westinghouse
54	500	350/700	250	d-c	Direct	Sendzimir mill	Chase Copper & Brass Co.	Waterville, Conn.	Westinghouse
55	500	735/1100	600	d-c	Direct	Temper pass mill	Kaiser Steel Corp.	Fontana, Calif.	Westinghouse
56	500	300/600	600	d-c	Geared	Scale Breaker	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
57	500	514	‡2300	a-c	Geared	80-in. Hot strip roughing mill, vertical edger	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
58	①500	600	350	d-c	Direct	Skin pass mill	Bethlehem Steel Co.	Sparrows Point, Md.	Westinghouse
59	①500	600	350	d-c	Direct	Skin pass mill	Bethlehem Steel Co.	Sparrows Point, Md.	Westinghouse
60	600	200/500	600	d-c	Geared	Reversing slab edger	Breedband, N. V.	Ijmuiden, Holland	General Electric
61	600	200/800	375	d-c	Geared	Tandem cold mill reel	Breedband, N. V.	Ijmuiden, Holland	General Electric
62	600	250/500	600	d-c	Direct	Temper mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
63	600	350/635	600	d-c	Direct	Temper mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
64	600	750	380	a-c	Geared	Rod mill	Sanchez y Gurmendi	Argentina	General Electric
65	①②600	1150/1500	600	d-c	Direct	Temper mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
66	①②600	1150/1500	600	d-c	Direct	Temper mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
67	①②600	850/1500	600	d-c	Direct	Temper mill delivery puller	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
68	①②600	850/1500	600	d-c	Direct	Temper mill delivery puller	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
69	②600	300/1500	750	d-c	Direct	Temper mill reel	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
70	600	175/525	600	d-c	Geared	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
71	600	175/525	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
72	600	250/625	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
73	600	250/625	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
74	600	375	230	d-c	Geared	Hot strip reversing edger	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
75	600	300/900	600	d-c	Direct	Combination reversing cold and temper pass mill	Cantieri de Metallurgici Italiani	Cantieri, Italy	Westinghouse
76	600	300/900	600	d-c	Direct	Combination reversing cold and temper pass mill	Cantieri de Metallurgici Italiani	Cantieri, Italy	Westinghouse
77	600	200/600	600	d-c	Geared	Temper pass mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
78	600	255/485	600	d-c	Direct	Skin pass mill	SOLLAC	France	Westinghouse
79	600	180/720	600	d-c	Direct	Tandem cold mill	Weirton Steel Co.	Weirton, W. Va.	Westinghouse
80	600	450/600	600	d-c	Direct	Temper pass mill	Kaiser Steel Corp.	Fontana, Calif.	Westinghouse
81	600	360	‡2300	a-c	Geared	Reeler for seamless tube mill	National Tube Co.	Lorain, Ohio	Elliott
82	600	360	‡2300	a-c	Geared	Reeler for seamless tube mill	National Tube Co.	Lorain, Ohio	Elliott
83	①700	250/720	600	d-c	Direct	Temper pass mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
84	①700	250/720	600	d-c	Direct	Temper pass mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
85	②700	225/950	600	d-c	Geared	Reversing cold mill reel	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
86	②700	225/950	600	d-c	Geared	Reversing cold mill reel	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
87	②700	225/950	600	d-c	Geared	Reversing cold mill reel	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
88	②700	225/950	600	d-c	Geared	Reversing cold mill reel	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
89	700	250/625	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
90	700	450/1070	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
91	750	720	‡2300	a-c	Geared	3-High roughing mill for rod	United Engineering & Foundry Co.		General Electric
92	①750	90/360	600	d-c	Direct	Reversing cold mill	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
93	①750	90/360	600	d-c	Direct	Reversing cold mill	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
94	①750	90/360	600	d-c	Direct	Reversing cold mill	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
95	①750	90/360	600	d-c	Direct	Reversing cold mill	Allegheny-Ludlum Steel Corp.	West Leechburg, Pa.	General Electric
96	†750	300	6600	a-c	Geared	Continuous billet mill	Bethlehem Steel Co.	Johnstown, Pa.	Westinghouse
97	†750	300	6600	a-c	Geared	Continuous billet mill	Bethlehem Steel Co.	Johnstown, Pa.	Westinghouse
98	†750	300	6600	a-c	Geared	Continuous billet mill	Bethlehem Steel Co.	Johnstown, Pa.	Westinghouse
99	†750	300	6600	a-c	Geared	Continuous billet mill	Bethlehem Steel Co.	Johnstown, Pa.	Westinghouse
100	800	300/1200	600	d-c	Geared	Temper mill reel	Breedband, N. V.	Ijmuiden, Holland	General Electric
101	②800	250/1000	600	d-c	Geared	Temper mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
102	②800	225/1000	600	d-c	Direct	Tandem cold mill reel	Kaiser Steel Corp.	Fontana, Calif.	General Electric
103	800	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
104	800	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
105	800	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
106	800	300/900	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
107	800	300/900	600	d-c	Geared	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
108	800	300/900	600	d-c	Geared	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
109	800	300/900	600	d-c	Geared	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
110	800	500/1150	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
111	800	175/680	600	d-c	Geared	Reversing cold strip mill reel	S.I.A.C.	Cornigliano, Italy	General Electric
112	800	175/680	600	d-c	Geared	Reversing cold strip mill reel	S.I.A.C.	Cornigliano, Italy	General Electric
113	②800	200/800	750	d-c	Direct	Tandem cold mill	Bethlehem Steel Co.	Sparrows Point, Md.	Westinghouse
114	800	150/525	600	d-c	Direct	Tandem cold mill	SOLLAC	France	Westinghouse
115	800	200/400	600	d-c	Direct	Skin pass mill	Carnegie-Illinois Steel Corp.	Gary, Ind.	Westinghouse
116	②800	200/800	600	d-c	Direct	Skin pass mill	Carnegie-Illinois Steel Corp.	Gary, Ind.	Westinghouse
117	800	300/900	600	d-c	Geared	Continuous rod mill	Continental Steel Corp.	Kokomo, Ind.	Allis-Chalmers
118	900	225/725	600	d-c	Geared	Temper pass mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
119	900	225/725	600	d-c	Geared	Temper pass mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
120	②1000	150/600	600	d-c	Direct	Tandem cold mill reel	Bethlehem Steel Co.	Sparrows Point, Md.	General Electric
121	1000	500/1000	600	d-c	Geared	Reversing cold strip mill	Thompson Wire Co.	Franklin Park, Ill.	General Electric
122	②1000	250/1060	600	d-c	Geared	Reversing cold mill reel	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
123	②1000	250/1060	600	d-c	Geared	Reversing cold mill reel	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
124	②1000	150/600	750	d-c	Direct	Tandem cold mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
125	②1000	200/800	600	d-c	Geared	Tandem mill reel motor	Ford Motor Co.	Detroit, Mich.	General Electric
126	②1000	350/875	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
127	1000	350/875	600	d-c	Direct	Bar mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	General Electric
128	1000	600	440	a-c	Geared	3-High, non-reversing aluminum hot mill	Reynolds International	Mexico	General Electric
129	②1000	175/640	600	d-c	Direct	Tandem cold strip mill reel	S.I.A.C.	Cornigliano, Italy	General Electric
130	1000	150/450	600	d-c	Geared	Reversing cold mill reel	Armco Steel Corp.	Ashland, Ky.	Westinghouse
131	1000	150/450	600	d-c	Geared	Reversing cold mill reel	Armco Steel Corp.	Ashland, Ky.	Westinghouse
132	1000	70/120	525	d-c	Direct	Hot mill edger	Reynolds Metals Co.	McCook, Ill.	Westinghouse
133	1000	110/275	600	d-c	Direct	Cold mill	Weirton Steel Co.	Weirton, W. Va.	Westinghouse
134	②1000	125/437	667	d-c	Direct	Tandem cold mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
135	②1000	125/437	667	d-c	Direct	Temper pass mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
136	1250	500/1000	550	d-c	Direct	Combination reversing cold and temper pass mill	Cantieri de Metallurgici Italiani	Cantieri, Italy	Westinghouse
137	1250	500/1000	575	d-c	Direct	Rod mill	Societe Anonyme des Houts Fourneaux de la Chiers	Chiers, France	Westinghouse
138	1250	300/460	600	d-c	Direct	Skin pass mill	SOLLAC	France	Westinghouse
139	②1250	400/1000	600	d-c	Geared	Hot and cold mill	Dow Chemical Co.	Midland, Mich.	Westinghouse
140	②1400	150/525	750	d-c	Direct	Tandem cold strip mill reel	Carnegie-Illinois Steel Corp.		General Electric
141	②1400	350/1700	750	d-c	Direct	Tandem cold strip mill reel	Carnegie-Illinois Steel Corp.		General Electric
142	1500	250/500	600	d-c	Geared	4-High skin pass mill	S.I.A.C.	Cornigliano, Italy	General Electric
143	1500	70/210	600	d-c	Direct	Tandem cold strip mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
144	1500	100/300	700	d-c	Direct	Breakdown mill	Dow Chemical Co.	Midland, Mich.	Westinghouse

*Indicates synchronous motor †Indicates induction motor ①Twin motor drive ②Double armature ③Triple armature

Item	Horse-power	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
145	1500	100/300	600	d-c	Direct	Vertical edging stand	Empire Steel Co.	Mansfield, Ohio	Westinghouse
146	1500	1775	2300	a-c	Direct	Hot strip descaling pump	Empire Steel Co.	Mansfield, Ohio	Westinghouse
147	1500	300/750	600	d-c	Geared	Continuous rod mill	Continental Steel Corp.	Kokomo, Ind.	Allis-Chalmers
148	②1600	175/650	600	d-c	Direct	Temper pass mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
149	1750	175/350	600	d-c	Direct	Combination reversing cold and temper pass mill	Cantieri de Metallurgici Italiani	Cantieri, Italy	Westinghouse
150	①1750	300/685	750	d-c	Geared	Tandem cold mill	Bethlehem Steel Co.	Sparrows Point, Md.	Westinghouse
151	①1750	300/685	750	d-c	Geared	Tandem cold mill	Bethlehem Steel Co.	Sparrows Point, Md.	Westinghouse
152	1750	110/310	750	d-c	Direct	Tandem cold strip mill	Carnegie-Illinois Steel Corp.		General Electric
153	①2000	40/80	500	d-c	Direct	Hot strip mill, 2-high reversing rougher	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
154	①2000	40/80	500	d-c	Direct	Hot strip mill, 2-high reversing rougher	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
155	2000	200/580	750	d-c	Geared	Tandem cold strip mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
156	2000	125/360	750	d-c	Geared	Tandem cold strip mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
157	2000	90/270	750	d-c	Direct	Tandem cold strip mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
158	2000	125/360	750	d-c	Direct	Tandem cold strip mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
159	2000	100/200	750	d-c	Geared	Slab mill edger	Armco Steel Corp.	Ashland, Ky.	General Electric
160	2000	80/180	600	d-c	Direct	Tandem cold strip mill	S.I.A.C.	Cornigliano, Italy	General Electric
161	2000	300/600	600	d-c	Geared	Rod mill	Jones & Laughlin Steel Corp.	Aliquippa, Pa.	General Electric
162	2000	300	4800	a-c	Geared	Billet mill	Rotary Electric Steel Corp.	Detroit, Mich.	Westinghouse
163	2000	300	4800	a-c	Geared	Billet mill	Rotary Electric Steel Corp.	Detroit, Mich.	Westinghouse
164	2000	300/600	600	d-c	Geared	Continuous rod mill	Continental Steel Corp.	Kokomo, Ind.	Allis-Chalmers
165	2000	150	13,800	a-c	Geared	80-in., Hot strip roughing mill scale breaker	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
166	2000	64	2300	a-c	Direct	Main mill drive for seamless tube mill	National Tube Co.	Lorain, Ohio	Elliott
167	①2250	200/415	750	d-c	Geared	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
168	①2250	200/415	750	d-c	Geared	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
169	①②2250	200/625	750	d-c	Geared	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
170	①②2250	200/625	750	d-c	Geared	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
171	2500	150/350	600	d-c	Direct	Cold mill	Weirton Steel Co.	Weirton, W. Va.	Westinghouse
172	2500	100/225	700	d-c	Direct	Cold mill	Dow Chemical Co.	Midland, Mich.	Westinghouse
173	2500	175/350	600	d-c	Direct	Reversing cold strip	Armco Steel Corp.	Ashland, Ky.	Westinghouse
174	①2500	225/475	600	d-c	Geared	Tandem cold strip mill	Bethlehem Steel Co.	Sparrows Point, Md.	General Electric
175	①2500	225/475	600	d-c	Geared	Tandem cold strip mill	Bethlehem Steel Co.	Sparrows Point, Md.	General Electric
176	①2500	225/500	600	d-c	Geared	Tandem cold strip mill	Bethlehem Steel Co.	Sparrows Point, Md.	General Electric
177	①2500	225/500	600	d-c	Geared	Tandem cold strip mill	Bethlehem Steel Co.	Sparrows Point, Md.	General Electric
178	2500	125/275	600	d-c	Direct	Tandem cold strip mill	Bethlehem Steel Co.	Sparrows Point, Md.	General Electric
179	2500	90/270	750	d-c	Direct	Tandem cold mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
180	2500	225/400	600	d-c	Direct	Reversing cold strip mill	S.I.A.C.	Cornigliano, Italy	General Electric
181	2500	110/275	600	d-c	Direct	Tandem cold strip mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
182	3000	150/340	750	d-c	Direct	Hot strip finishing mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
183	3000	150/300	600	d-c	Direct	Hot strip finishing mill	Allegheny Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
184	①②3000	345/635	750	d-c	Geared	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
185	①②3000	345/635	750	d-c	Geared	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
186	3000	110/265	600	d-c	Direct	Tandem cold strip mill	S.I.A.C.	Cornigliano, Italy	General Electric
187	②3000	160/400	600	d-c	Direct	Tandem cold strip mill	S.I.A.C.	Cornigliano, Italy	General Electric
188	②3000	175/425	600	d-c	Direct	Tandem cold strip mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
189	②3000	275/610	600	d-c	Direct	Tandem cold strip mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
190	3000	90/270	750	d-c	Direct	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
191	*3000	600	6900	a-c	Geared	Hot strip mill roughing stands	Armco Steel Corp.	Ashland, Ky.	Westinghouse
192	3000	70/175	700	d-c	Direct	Reversing hot strip mill	Altos Hornos	Monclova, Mexico	Westinghouse
193	3000	80/200	600	d-c	Direct	Tandem cold mill	SOLLAC	France	Westinghouse
194	3000	100/250	600	d-c	Direct	Tandem cold mill	SOLLAC	France	Westinghouse
195	3000	125/350	600	d-c	Direct	Tandem cold mill	SOLLAC	France	Westinghouse
196	②3000	250/500	600	d-c	Direct	Cold mill	Weirton Steel Co.	Weirton, W. Va.	Westinghouse
197	②3000	312/625	600	d-c	Direct	Cold mill	Weirton Steel Co.	Weirton, W. Va.	Westinghouse
198	*3000	514	11,000	a-c	Geared	Bar mill	Detroit Steel Corp.	Portsmouth, Ohio	Westinghouse
199	†3000	514	13,200	a-c	Geared	Hot strip mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
200	3000	125/250	600	d-c	Direct	Hot strip mill	Empire Steel Co.	Mansfield, Ohio	Westinghouse
201	3000	80/200	750	d-c	Direct	Tandem cold mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
202	3500	140/280	700	d-c	Geared	Hot strip mill	Armco Steel Corp.	Ashland, Ky.	Westinghouse
203	①3500	35/80	700	d-c	Direct	Reversing plate mill	Sheffield Steel Corp.	Houston, Tex.	Westinghouse
204	①3500	35/80	700	d-c	Direct	Reversing plate mill	Sheffield Steel Corp.	Houston, Tex.	Westinghouse
205	①3500	40/80	700	d-c	Direct	Reversing slabbing mill	SOLLAC	France	Westinghouse
206	①3500	40/80	700	d-c	Direct	Reversing Slabbing Mill	SOLLAC	France	Westinghouse
207	†3500	514	13,200	a-c	Geared	Hot strip mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
208	†3500	450	13,200	a-c	Geared	Hot strip mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
209	†3500	450	13,200	a-c	Geared	Hot strip mill	Ford Motor Co.	Detroit, Mich.	Westinghouse
210	3500	55/110	750	d-c	Direct	Hot strip finishing mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
211	3500	90/180	750	d-c	Direct	Hot strip finishing mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
212	3500	125/250	750	d-c	Direct	Hot strip finishing mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
213	3500	150/352	600	d-c	Geared	Hot strip finishing mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
214	3500	125/250	600	d-c	Direct	Hot strip finishing mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
215	3500	150/300	600	d-c	Geared	Reversing cold mill	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
216	①3500	40/80	750	d-c	Direct	Blooming and slabbing mill	Pittsburgh Steel Co.	Monessen, Pa.	General Electric
217	①3500	40/80	750	d-c	Direct	Blooming and slabbing mill	Pittsburgh Steel Co.	Monessen, Pa.	General Electric
218	3500	165/420	750	d-c	Direct	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
219	②3500	228/550	600	d-c	Direct	Tandem cold strip mill	S.I.A.C.	Cornigliano, Italy	General Electric
220	②3500	400/745	600	d-c	Direct	Tandem cold strip mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
221	3500	150	13,800	a-c	Geared	80-in., Hot strip roughing mill	Carnegie-Illinois Steel Corp.		Allis-Chalmers
222	②4000	150/325	600	d-c	Direct	Tandem cold strip mill	Bethlehem Steel Co.	Sparrows Point, Md.	General Electric
223	4000	150/300	600	d-c	Geared	Hot strip finishing mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
224	4000	100/200	600	d-c	Direct	Hot strip finishing mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
225	②4000	125/360	750	d-c	Direct	Tandem cold strip mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
226	②4000	200/500	750	d-c	Direct	Tandem cold strip mill	Detroit Steel Corp.	Portsmouth, Ohio	General Electric
227	4000	50	700	d-c	Direct	Blooming mill	Sheffield Steel Corp.	Kansas City, Mo.	Westinghouse
228	4000	110/242	700	d-c	Geared	Hot strip mill	Armco Steel Corp.	Ashland, Ky.	Westinghouse
229	4000	150/330	700	d-c	Direct	Hot strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westipghouse
230	②4000	200/485	750	d-c	Direct	Tandem cold mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
231	①4000	40/100	800	d-c	Direct	Blooming mill	Bethlehem Steel Co.	Johnstown, Pa.	Westinghouse
232	①4000	40/100	800	d-c	Direct	Blooming mill	Bethlehem Steel Co.	Johnstown, Pa.	Westinghouse
233	4500	125/250	700	d-c	Geared	Hot strip mill	Armco Steel Corp.	Ashland, Ky.	Westinghouse
234	4500	125/250	700	d-c	Geared	Hot strip mill	Armco Steel Corp.	Ashland, Ky.	Westinghouse
235	4500	100/200	700	d-c	Geared	Hot strip mill	Armco Steel Corp.	Ashland, Ky.	Westinghouse
236	4500	125/250	700	d-c	Geared	Hot strip mill	Armco Steel Corp.	Ashland, Ky.	Westinghouse
237	4500	185/350	600	d-c	Geared	Hot strip mill	Armco Steel Corp.	Middletown, Ohio	Westinghouse
238	4500	185/350	600	d-c	Geared	Hot strip mill	Armco Steel Corp.	Middletown, Ohio	Westinghouse
239	4500	185/350	600	d-c	Geared	Hot strip mill	Armco Steel Corp.	Middletown, Ohio	Westinghouse
240	②4500	225/450	600	d-c	Geared	Hot strip mill	Youngstown Sheet and Tube Co.	Indiana Harbor, Ind.	Westinghouse
241	②4500	125/290	750	d-c	Direct	Tandem cold mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
242	②4500	175/430	750	d-c	Direct	Tandem cold mill	Republic Steel Corp.	Cleveland, Ohio	Westinghouse
243	4500	100/200	600	d-c	Direct	Hot strip finishing mill	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
244	4500	125/250	600	d-c	Direct	Hot strip finishing mill	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
245	4500	140/280	600	d-c	Direct	Hot strip finishing mill	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
246	①5000	40/100	700	d-c	Direct	Blooming mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	Westinghouse
247	①5000	40/100	700	d-c	Direct	Blooming mill	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	Westinghouse
248	*5000	600	6900	a-c	Geared	Hot strip mill roughing stand	Armco Steel Corp.	Ashland, Ky.	Westinghouse
249	*5000	600	6900	a-c	Geared	Hot strip mill roughing stand	Armco Steel Corp.	Ashland, Ky.	Westinghouse
250	*5000	600	6900	a-c	Geared	Hot strip mill roughing stand	Armco Steel Corp.	Ashland, Ky.	Westinghouse
251	5000	40/120	700	d-c	Direct	Breakdown mill	Dow Chemical Co.	Midland, Mich.	Westinghouse
252	5000	125/250	700	d-c	Geared	Hot strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
253	5000	125/250	700	d-c	Geared	Hot strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
254	5000	80/160	700	d-c	Direct	Hot strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
255	5000	100/220	700	d-c	Direct	Hot strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
256	5000	125/270	700	d-c	Direct	Hot strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Westinghouse
257	5000	257	13,800	a-c	Geared	Piercer for seamless tube mill	National Tube Co.	Lorain, Ohio	Elliott

*Indicates synchronous motor †Indicates induction motor ①Twin motor drive ②Double armature ③Triple armature

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

(CONTINUED)

Item	Horsepower	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
258	5000	257	13,800	a-c	Geared	Piercer for seamless tube mill	National Tube Co.	Lorain, Ohio	Elliott
259	①5250	250/565	750	d-c	Direct	Tandem cold strip mill	Carnegie-Illinois Steel Corp.		General Electric
260	6000	50/120	600	d-c	Direct	Hot strip reversing rougher	Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	General Electric
261	6000	40/80	600	d-c	Direct	Reversing slabbing mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
262	6000	40/80	600	d-c	Direct	Hot strip reversing roughing mill	Breedband, N. V.	Ijmuiden, Holland	General Electric
263	②6000	150/350	750	d-c	Direct	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
264	②6000	200/500	750	d-c	Direct	Tandem cold strip mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	General Electric
265	6000	240	13,800	a-c	Geared	80-in., Hot strip roughing mill, 4-high universal mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
266	6000	360	13,800	a-c	Geared	80-in., Hot strip roughing mill, 4-high universal mill	Carnegie-Illinois Steel Corp.	Morrisville, Pa.	Allis-Chalmers
267	7000	40/80	750	d-c	Direct	Slabbing mill	Armco Steel Corp.	Ashland, Ky.	General Electric
268	7000	50/120	750	d-c	Direct	Blooming mill	Algoma Steel Corp.	Sault Sainte Marie, Canada	General Electric

Indicates synchronous motor †Indicates induction motor ①Twin motor drive ②Double armature ③Triple armature

MOTOR RECAPITULATION

Company	Location	Type of mill	Number of motors	Total horsepower
Algoma Steel Corp.	Sault Ste. Marie, Canada	Blooming mill	1	7,000
Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	Hot strip mill	6	23,000
	West Leechburg, Pa.	Reversing cold mill	11	11,300
Altos Hornos	Moncloca, Mexico	Reversing hot strip mill	1	3,000
Armco Steel Corp.	Ashland, Ky.	Slabbing mill	2	9,000
		Reversing cold strip mill	3	4,500
		Hot strip mill	11	43,850
	Middletown, Ohio	Hot strip mill	3	13,500
Bethlehem Steel Co.	Johnstown, Pa.	Continuous billet mill	4	3,000
		Blooming mill	2	8,000
		Tandem cold mill	1	800
	Sparrows Point, Md.	Skin pass mill	2	1,000
		Tandem cold strip mill	9	21,000
Breedband, N. V.	Ijmuiden, Holland	Temper mill	5	2,700
		Tandem cold strip mill	5	8,600
		Hot strip mill	5	21,000
		Reversing slabbing mill	2	6,600
Bristol Brass Corp.	Portsmouth, Ohio	Brass mill	1	400
Cantieri de Metallurgici Italiani	Cantieri, Italy	Combination reversing and temper mill	4	4,200
Carnegie-Illinois Steel Corp.	Gary, Ind.	Skin pass mill	2	1,600
	Morrisville, Pa.	Tandem cold strip mill	14	43,300
		Two stand temper mill	7	2,600
		80-in., hot strip mill	12	47,500
		Temper pass mill	5	3,600
Chase Copper and Brass Co.	Waterville, Conn.	Cold brass mill	3	1,100
		Sendzimir mill	1	500
Continental Steel Corp.	Kokomo, Ind.	Continuous rod mill	4	4,700
Crucible Steel Co. of America	Midland, Pa.	Temper pass mill	1	400
Detroit Steel Corp.	Portsmouth, Ohio	Tandem cold strip mill	4	11,500
		Temper mill	2	800
		Hot strip mill	7	18,100
		Bar mill	1	3,000
Dow Chemical Co.	Midland, Mich.	Cold mill	2	2,850
		Hot and cold mill	1	1,250
		Breakdown mill	2	6,500
Empire Steel Co.	Mansfield, Ohio	Hot strip mill	3	6,000
Fiat Co.	Turin, Italy	Reversing cold strip mill	1	400
Ford Motor Co.	Detroit, Mich.	Tandem mill reel motor	1	1,000
		Hot strip mill	4	13,500
Granite City Steel Co.	Granite City, Ill.	48-in., 2-stand temper mill	2	450
Jones & Laughlin Steel Corp.	Aliquippa, Pa.	Temper mill	9	4,900
	Pittsburgh, Pa.	Rod mill	9	7,200
		Bar mill	12	9,000
		Blooming mill	2	10,000
Kaiser Steel Corp.	Fontana, Calif.	Tandem cold strip mill	6	14,300
		Temper pass mill	5	2,000
National Tube Co.	Lorain, Ohio	Seamless tube mill	5	13,200
Pittsburgh Steel Co.	Monessen, Pa.	Blooming and slabbing mill	2	7,000
Republic Steel Corp.	Cleveland, Ohio	Temper pass mill	4	3,400
		Tandem cold mill	5	17,000
Reynolds International	Mexico	3-High, non-reversing aluminum hot mill	1	1,000
Reynolds Metals Co.	McCook, Ill.	Hot mill edger	1	1,000
Revere Copper and Brass, Inc.	Chicago, Ill.	6-in., 28 in. x 30-in., reversing brass mill	2	600
	Detroit, Mich.	6-in., 28-in. x 30-in., reversing brass mill	2	600
	Rome, N. Y.	6-in., 28-in. x 30-in., reversing brass mill	4	1,200
Rotary Electric Steel Corp.	Detroit, Mich.	Billet mill	2	4,000
Sanchez y Gurmendi	Argentina	Rod mill	1	600
Sheffield Steel Corp.	Kansas City, Mo.	Blooming mill	1	4,000
	Houston, Tex.	Reversing plate mill	2	7,000
S.I.A.C.	Cornigliano, Italy	4-High, skin pass mill	2	1,950
		Tandem cold strip mill	5	12,500
		Reversing cold strip mill	3	4,100
Societe Anonyme des Hauts Forneaux de la Chiers	Chiers, France	Rod mill	1	1,250
SOLLAC	France	Temper pass mill	3	1,000
		Skin pass mill	3	2,350
		Tandem cold mill	4	9,800
		Reversing slabbing mill	2	7,000
Thompson Wire Co.	Franklin Park, Ill.	Reversing cold strip mill	3	1,600
United Engineering & Foundry Co.		Rod mill	4	1,950
Weirton Steel Co.	Weirton, W. Va.	Tandem cold mill	5	10,100
Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	Hot strip mill	1	4,500

Type of motors purchased	Number of motors	Total horsepower
Alternating current motors	32	77,750
Direct current motors	236	451,450
Total	268	529,200

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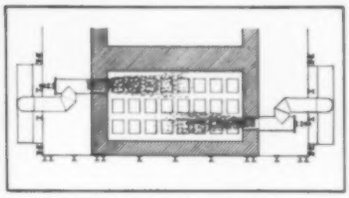
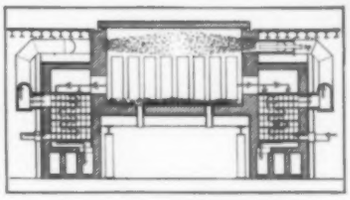
- Choice of Fuels



PLAN VIEW



CROSS SECTION

Thanks to superior design, Rust Soaking Pits have greater charging capacity per square foot of area. Sketches above indicate the diagonal two-way firing, by which heat is distributed uniformly throughout the pit; on cut backs both ends of pit remain in balance, thus ingots soak out evenly. absence of impingement increases life of refractory walls and covers.

Design permits construction in batteries of two or more holes. With 45 years of experience as a background, Rust engineering from start to finish guarantees the utmost in efficiency and economy.

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ONE RUST CONTRACT covers everything . . . from blueprint to test-run. Rust assumes responsibility for design, manufacture and erection of all essential material . . . including excavations, foundations, wiring and piping. Your purchasing and engineering departments are freed of subcontractor headaches when you order from Rust.

F-3

RUST FURNACE CO.

PIONEERS IN FURNACE DESIGN

PITTSBURGH, PENNSYLVANIA

"We don't have any more needless fuse blows on our Air Compressor circuit since we installed FUSETRON dual-element FUSES"

"Prior to the time we installed Fusetron fuses to protect the circuit feeding the 125 h.p. 220 volt, 3 phase motor on our air compressor we were troubled with fuses blowing needlessly.

"On an average of once every two weeks one of the 400 ampere, 250 volt renewable fuses protecting the circuit would open on the starting current of the motor.

"About May of 1947 we replaced the fuses with 400 ampere Fusetron fuses. Since then we have not had the circuit down once because of a needless blow."

Leon C. England.
Chief Electrician
Link Belt Company
Indianapolis, Ind.

Fusetron DUAL ELEMENT Fuses

give 10-Point Protection

1★ Protect against short circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

★ Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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Act on the Facts

Don't risk losses in your plant

One **needless** shutdown,
One **lost** motor,
One **destroyed** panel or switch,
One **burned out** solenoid—

May cost you more than replacing every ordinary fuse with a FUSETRON dual-element fuse.

But, simply knowing that FUSETRON fuses do save money is knowledge — but it isn't action.

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What is the FUSETRON Dual-Element FUSE?

A fuse link combined with a thermal cutout—the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses, FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

(FUSETRON is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.)

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Please send me complete facts about FUSETRON Dual-Element FUSES.

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*City*_____ *State*_____ 181

HORIZONTAL CONTINUOUS CASTING MACHINE

▲ The continuous casting process when successfully developed will eliminate many of the inconveniences which are inherent in the conventional methods of ingot castings. A new development in continuous casting has recently been patented by J. F. Jacquet, technical secretary of the Belgian Blast Furnace and Steel Work Association. This system claims the following advantages:

1. Production of small cross-section ingots which can be rolled directly by the finishing mills, thus eliminating the need of soaking pits and blooming mills.

2. Rapid cooling of ingots giving the metal a fine and uniform crystalline structure and a very limited segregation of the secondary components.

3. Positive elimination of pipe and hence cropping, because of the constant feeding of hot metal.

4. Noticeable reduction of cracks and scratches in the ingot skin.

5. Mechanization of the steel ingot casting operation.

The primary differences with existing methods are that the molds are directly connected to the ladles and the ingots are cast in the horizontal position. The small size of the ingot gives rapid cooling which limits segregation and gives a uniform crystalline structure.

Figure 1 is a cross-section through the unit. Its operation is as follows:

The ladle (1) with a refractory lining (2) is composed of a steel plate side wall (3) riveted to a bottom (4) which will be preferably of cast iron, in order to withstand deformation. The outside surface of the bottom, bearing the other parts, will be machined. The ladle is a separate unit in relation to its support (5) which is of cast iron or of cast steel. The iron bottom (4) of the ladle will be provided with six holes enabling the flow of metal through the nozzles (6). The diameter of the nozzles should be as large as possible. A pit (7) will be provided for under the support (5). In this pit will be arranged a track (8) on which a carriage mounted on rollers (9) will move. The installation could also be mounted entirely above the floor level. Six cylinders (10) will be placed on this carriage, in each of which a plunger (11) will move, which can be lifted or lowered through a hand-wheel (12). The upper part of the plungers (11) will be adequately shaped in order to receive the metallic box (13) which it has to support (see Figure 2).

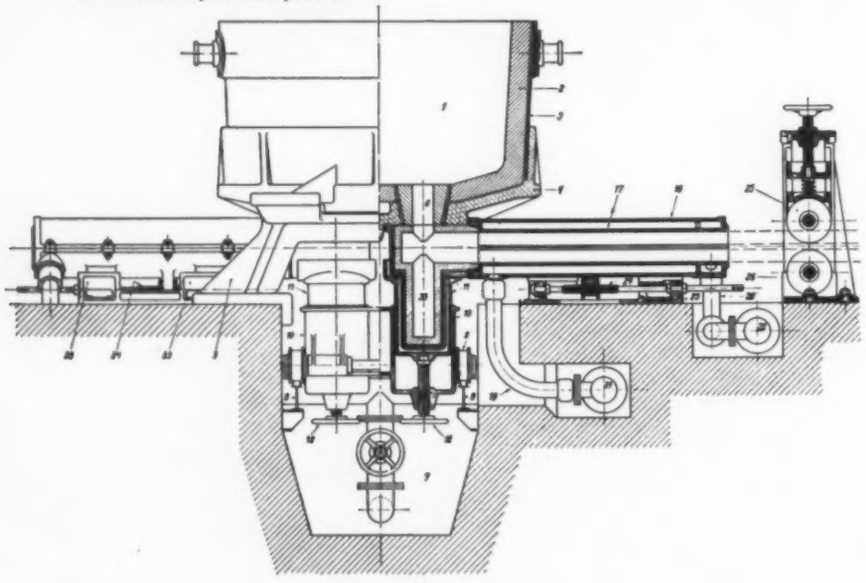
To prepare the equipment for an ingot casting operation, the ladle (1) should be placed on its support (5). The metallic boxes (13) should also be placed on the upper part of the plungers (11), the carriage is not now under the ladle but rolled away to a more accessible place of the pit (7).

The brick (14) is then placed in each of the boxes (13), and the carriage is moved forward under the ladle until the stop provided controls its position adequately. By means of hand-wheels (12), the plungers (11) and consequently the boxes (13) are lifted until the top face of the bricks (14) come against the machined base face of the bottom (4) of the ladle (1). The upper face of the bricks (14) should be slightly coated beforehand with mortar in order to obtain a perfectly tight contact between those two faces.

Each of the six ingot molds (17) is provided with a jacket (18) connected through elbows (19 and 20) respectively (Figure 1) to cooling water feed and outlet pipes (21 and 22). The ingot molds (17) are lying on cradles (23) and can be moved lengthwise by means of the screws (24).

When the bricks (14) have their upper faces pressed against the bottom of the ladle, the ingot molds (17) should be brought nearer to the bricks (14) the truncated conical end of which is also coated with mortar, in order to insure a perfectly tight joint. The ingot molds are secured against any backing away movement by the necessary means. A stopper ingot (always the same) will then be inserted in each ingot mold in order to fill its inside space. That stopper ingot will extend to the outside so that its end is between the two pinch rolls (25 and 26), the opening and the speed of which are variable and are rotating in opposite directions.

Figure 1 — Drawing on this proposed casting machine shows the layout of the component parts.



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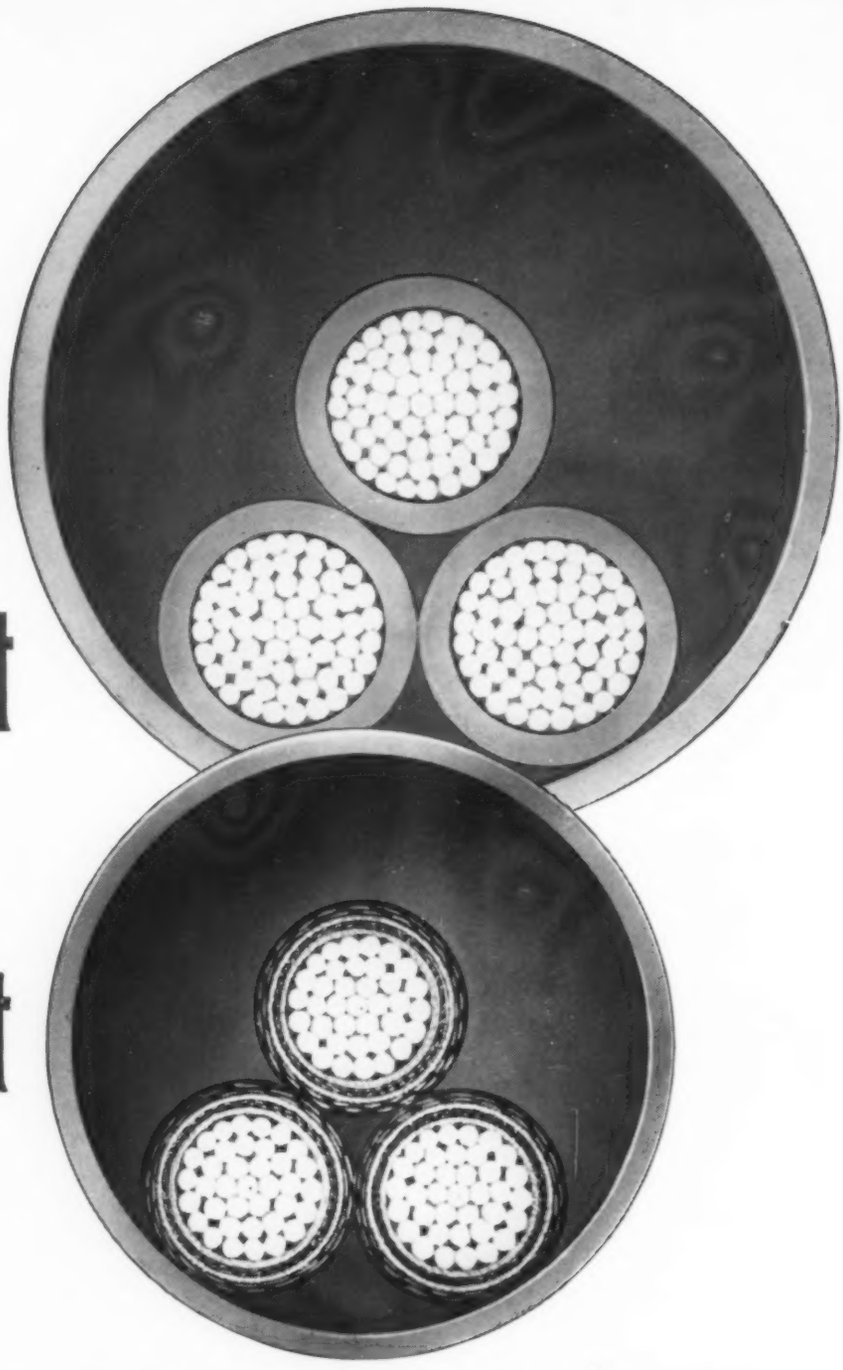

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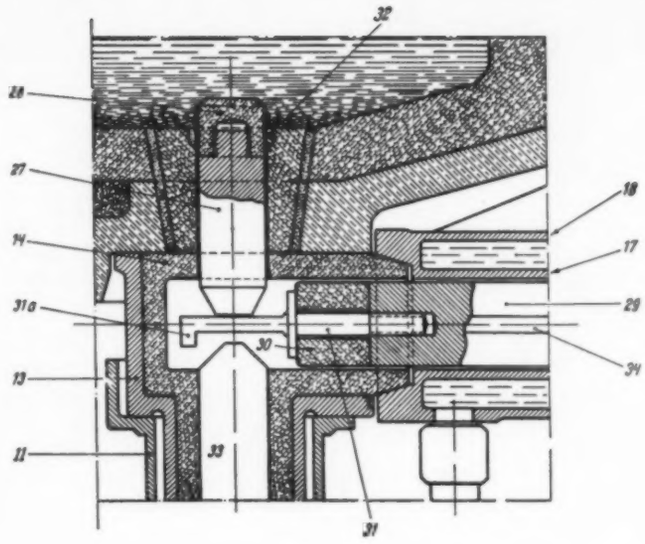

Figure 2 — Sketch shows details of stopper ingot.

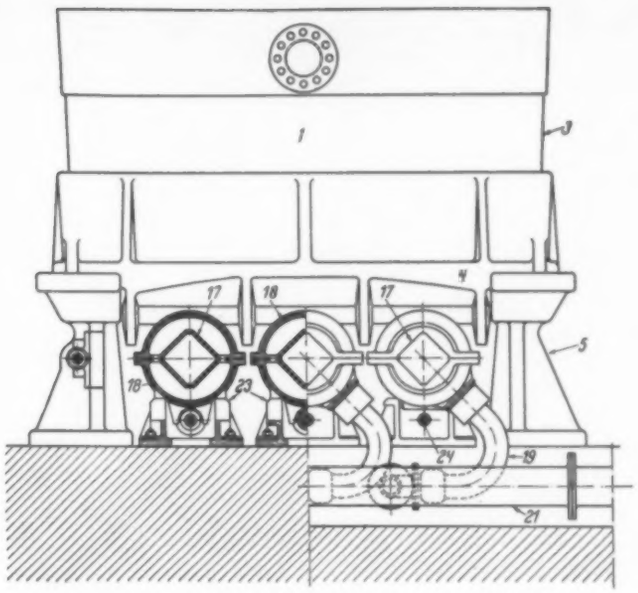

Figure 3 — Section through the ingot molds.

Figure 2 shows, as an example, how the stopper ingot (29) can be fitted. The refractory part (30) which lengthens it and which has a similar cross-section is intended to avoid the liquid steel from coming in contact directly with the stopper ingot, as soon as metal begins to flow, which could create some inconveniences.

The refractory part (30) and the stopper ingot (29) are connected to each other by a metal part (31), one end of which is screwed in the stopper ingot, the other end being bent as indicated on the design (31a). The nozzles (6) of the ladle will then be stopped by stoppers (27 and 28). These stoppers will be of a metal lower part (27), of cast iron, and of a refractory part (28) screwed on it. The base of each stopper bears on the metal part (31) which will support it.

During the filling of the ladle, the metal should be prevented from seeping through between the stopper (27-28) and the wall of the discharging hole or nozzle (6). For that purpose, the cross-section of this discharging hole is not uniform over its entire length. The bore of this hole will be slightly larger at the top as indicated on Figure 2, so that it is possible to press a refractory material (32) in that place in order to insure a perfect sealing which would not be possible, even if there would be a minimum clearance between these two parts.

The equipment being thus prepared, the metal charge to be cast into ingot molds is poured in the ladle (1). To begin the operation, water is allowed to flow into the jackets (18), then the pinch rolls (25 and 26) are started and they pull away the stopper ingots (29). As soon as the stoppers (27-28) are no longer supported by the metal part (31), they fall into the recesses (33) provided below, in which they will remain during the duration of the casting operation. The steel will flow through nozzles (6), will flow through the bricks (14), and following the refractory parts (30) will go into the ingot molds, where it will solidify under the effect of the cooling water circulating in jackets (18).

During its flow into the ingot molds, the steel has to undergo a drop in its temperature of approximately 1100 F. The steel, therefore, has to be subjected to the effect of the coolant for a longer time than the non-ferrous metals. As a result, the stripping of the steel can be effected only at a comparatively reduced speed. Too rapidly stripped ingots would show a central cavity, the elimination of which constitutes the essential object of the continuous casting.

When we multiply the number of ingot molds, the cooling surfaces are obviously increased in the same proportion and hence the efficiency of the cooling system and the output of the equipment.

Therefore, this equipment will enable the casting of steel on a commercial scale, without the necessity of reheating the charge and without exceeding the maximum stripping speed.

At the same time this device has, in addition, other very important features.

The fact that in this method the ingot molds are connected with the ladle without interruption of the continuity offers essential advantages. During the greater part of the operation, the metal contained in the ladle will exert on the ingots being cast such a pressure that the skin of these ingots will remain in contact with the wall of the ingot molds over a much larger surface than in the equipment where that direct connection is not provided for.

On the other hand, the risks of cracking and breaking the ingot skin will be very much reduced in view of the lower pressure that the ingots being cast are subjected to. Furthermore, because of this same feature, the flow of metal will take place in "closed vessel," and the liquid steel will therefore be protected from oxidation.

Another advantage of the above described method lies in the fact that the ingot molds are positioned horizontally. As a result, the cutting off of the ingots is not at all necessary during the course of the operation; this can be done when the operation is completed. If necessary, the six ingots of the same casting could be cut into pieces in variable lengths, whereas the vertical systems do not give this possibility without suspending operation.

Belgameric, Inc. has obtained the exclusive agency for the Jacquet Patents for the U. S. A., Belgium, Luxembourg, France and Italy.

Tennessee Coal, Iron & Railroad Co.

OPENS CONCORD MINE

▲ High quality coal is an important factor in steel manufacture. As a major development in production and processing of this vital raw material in the South, Tennessee Coal, Iron and Railroad Company, a United States Steel subsidiary, has recently put into operation its new Concord mine. It is located near Hueytown, Alabama, about 15 miles west of Birmingham. Equipped with the most modern devices to insure for employees safe and comfortable operations, together with maximum coal production and quality, the Concord Mine has utilized the latest approved developments in mine engineering underground, and coal cleaning facilities above ground. When at full capacity, the new mine will produce 7500 tons of washed coal a day.

Cutting operations at the working faces are performed by electrically powered, rubber-tire mounted mining machines, adjustable to any position for under, over or side cutting. After blasting by permissible explosives, mechanical mobile loaders, caterpillar mounted, load the blasted coal into shuttle cars at a maximum rate of 5 tons a minute.

To provide unobstructed haulage ways and working areas, roofs in the new Concord Mine are pinned, making the general use of timbering unnecessary.

The Concord mine is equipped with eight-wheel, 7-ton capacity mine cars with automatic swivel couplings. The cars are hauled by 8-ton electric gathering locomotives. The main-line locomotives are 20-ton electrics.

Because of the interlaying of rock and coal in this seam, known locally as the American seam, and because of the exceptionally friable nature of the coal, elaborate installations had to be provided for adequate separating, cleaning and blending.

The coal with its rock inclusions is hauled to a two-car rotary dump which is operated by three, 15 hp motors. This installation was designed and built by Tennessee Coal, Iron and Railroad Company. The dump is fed from a system of car hauls, also TCI designed and built. There are two parallel tracks with two cable car hauls, each feeding 15 loads at a time to the dump car haul. This haul, which is equipped with car stops, feeds the cars through the dump two at a time.

From the 75-ton capacity dump hopper, coal and rock are removed by two apron feeders, each discharging to a magnetic pulley belt for the removal of tramp iron head of a scalping screen. The apron feeders are of manganese steel, 60 in. wide, 8 ft long and travel 20 fpm. The magnetic belt separators are 60 in. wide, 15 ft long and travel 200 fpm. They are equipped with 42-in. diam, 60-in.-face magnetic head pulleys for removal of tramp iron.

There are two heavy-duty, foundry type, 5 by 10-ft single-deck scalping screens. They have grizzly-type decks and to prevent blinding, the openings taper from 6½ in. at the feed end to 7½ in. at the discharge end. The oversize from the screens is reduced to minus 8 in. in two, 36-in. diam by 54-in-face, single-roll crushers, operating at 59 rpm.

The crushed oversize and the screen undersize are dropped into a 60-ton double surge bin, from which the material is removed by two apron feeders. These are heavy-duty feeders, 36 in. wide, 8 ft long and travel at 60 fpm. The apron feeders drop the crushed run-of-mine coal onto a 42-in. buffer belt with 88-ft centers. With a slope of slightly more than 17 degrees and traveling at 575 fpm, the buffer belt brings the flow of material up to the speed of the main slope belt.

The main slope belt at the time of its installation was the largest of its kind, insofar as horsepower and lift were concerned. With a maximum pull of 80 tons on the head pulley, the belt stresses were so great that a steel cable core head had to be built into the belt fabric. This belt is 42 in. wide and has a total lift of 730 ft. It is slightly under 4900 ft long on centers of about 2450 ft. It has a capacity of 1000 tons an hour. Drive is imparted by double pulleys with a 270-degree belt wrap on each pulley. Power for the lower pulley is developed by two 300 hp motors with herringbone speed reducers, and for the upper pulley by one 300-hp motor and reducer. The belt slope is 17 degrees, 21 minutes and the head pulley is 73 ft above the ground. Tension is maintained by a gravity take-up.

A rectangular magnet, suspended over the head pulley of the main slope belt, removes the tramp iron which was missed by the magnetic-belt separator below ground. The coal and rock spill into a separator car which divides the flow into two streams to feed two parallel lines of equipment. The separator car, designed by Tennessee Coal, Iron and Railroad Company, can be set to separate the stream of material or, for maintenance purposes, to divert the total flow into either of the two processing lines. Any breakdown in either of the two lines automatically sets the separator car to divert the stream to the other. In case of emergency, each of the two lines is capable of handling close to total mine capacity.

In the two processing lines, the coal and rock first pass over double-deck, heavy-duty vibrating screens. These screens are 6 by 12 ft with "non-blinding" grizzly-type top decks with tapered openings for a nominal 8-in. separation. The top deck oversize, which is all rock, goes to a single-roll crusher. The bottom deck, equipped with 2-in. square openings, discharges its oversize to a revolving breaker. The 2-in. by zero bottom deck undersize drops to a 48-in. conveyor for transport to the blending bins.

The single-roll crusher is 36 in. in diam with a 54-in. face and operates at 59 rpm. It reduces the rock to minus 3 in. and delivers it onto a conveyor for transport to the rock bin. All rock from the Concord mine is crushed as a dump fire-control measure.

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The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

The revolving breakers are 9 ft in diam and 14 ft long, with 2-in. round perforations in the shells. There are no fins as in conventional breakers, the grinding action of the rock being sufficient to reduce the coal to minus 2 in. The coal falls through the perforations to a 48 in. conveyor for transport to the blending bins. The rock is tumbled through the breaker and discharged to the single-roll crusher. The conveyor from the crusher is 36 in. wide, operates on 261-ft centers and travels 212 fpm. It discharges into a 150-ton bin. The crushed rock from the bin is loaded into 22-ton semi-trailer trucks for disposal on the dump area. The transfer conveyor from the vibrating screens and the revolving breakers is 48 in. wide, operates on 178-ft centers and travels 383 fpm on an 18-degree slope to the blending bins.

Coal from the blending bins is delivered through feeder gates mounted below each of the 24 pockets to eight feeder belts, each serving three pockets. The feeder belts, which discharge to the main collector belt, are 30 in. wide and operate on 43-ft centers at variable speed. The gates are air operated and only one gate of the three in each set can be opened at one time.

To make sure that the coal from the gates is moving, it is necessary to keep all eight belts under continual observation. To eliminate the constant walking involved in this patrol, a plant employee designed a simple wooden paddle to be mounted over each of the feeder belts. The blades of the paddle are turned as the coal passes under them. An observer from any point on the floor can now determine if the coal is moving simply by observing whether all the paddle wheels are in motion.

The main collector belt from the bins is 54 in. wide and operates on 525-ft centers at 435 fpm up a 20-degree slope. This belt carries the 2-in. by zero raw coal to a surge bin at the top of the preparation building.

From the 25-ton capacity surge bin, coal is removed by a feeder belt 72 in. wide, operated on 15-ft centers at variable speed. This belt delivers coal to a 60-in. drag conveyor operating on 94-ft centers. The flights of the drag conveyor are spaced at 3-ft intervals. This conveyor scrapes the coal over a series of five graduated openings, each of which permits coal from different areas of the flight to drop onto a vibrating screen for wet screening.

The five, double-deck vibrating screens are 6 by 16 ft, with ¾ in. square openings in the top deck. The bottom deck has $\frac{5}{16}$-in. square openings. There are four rows of water sprays on each screen, and oversize from both decks recombines and collects on a 42-in. wide conveyor for transport to a cone gravity separator.

The screen undersize and water containing 40 per cent solids are conducted to a primary distributor.

The gravity separator is 12-ft diameter cone where a sand-water medium separates the oversize from the vibrating screen into washed coal and refuse, in the proportions of one part washed coal to two parts refuse. The sand in the tank is kept in suspension by an agitator. A torque control on the agitator automatically opens butterfly valves for the removal of refuse.

The undersize pulp from the raw-coal sizing screens flows to a primary distributor, designed and built by Tennessee Coal, Iron and Railroad Company. This distributor is 9 ft in diameter and 9 ft high. It consists of a revolving top cylinder with seven outlets, three stationary compartmented bottom pans with four, five and six compartments and one bottom pan with seven compartments. The bottom pan will produce seven splits when held stationary, or eight splits when revolved. Arranged under the distributor are eight flumes fed by swivel spouts from the bottom pan. The primary distributor divides the ¼-in. by zero pulp into from two to eight parts, all parts being quantitative and qualitative equals. The number of splits can be changed without stopping the flow of feed. Each split flows to a secondary distributor for further division into feeds for the individual concentrating tables.

There are 64 concentrating tables consisting of eight sections of eight tables each. These are 8 by 16-ft diagonal-deck tables. Here the feed is separated into washed coal and refuse. The refuse flows to four drag dewatering tanks. Each serves two table sections. The refuse from these tanks is discharged to a 30-in. collecting belt conveyor. The water overflow passes to a 175-ft diameter thickener for further clarification.

The coal-bearing pulp from the tables is dewatered on eight 6 by 16-ft horizontal vibrating screens with ½-millimeter stainless steel cloth. Each screen serves a section of eight tables. The dewatered oversize is collected on a conveyor while the fine coal and water slurry pass through the screen and flow to two hydroseparator tanks.

The water laden with solids passing through the dewatering screens is split to feed the two hydroseparators, which are 70 ft in diameter. They are concrete tanks, each equipped with an automatic rake-lifting device. Here the solids settle and thicken and are raked to the center. They are withdrawn and pumped back through a distribution tank to the dewatering screens to serve as a second layer. The hydroseparators make a separation of approximately 270 mesh. Materials below that size overflow with the water and go to the 175-ft thickener.

The dewatered washed coal from the concentrating tables and from the gravity separator is combined and conveyed to a 300-ton storage bin from which it is loaded into cars and shipped to the coke works. Refuse from the gravity separator and from the concentrating tables is combined and conveyed to a 300-ton storage bin, from which it is hauled to the dumping area.

Clarified water from the thickener is returned to the plant circuit. The use of fresh water for pump glands, wash-down hoses and spray nozzles supplies sufficient plant make-up water. A high outside wall on the thickener permits it to serve as a reservoir for all the water in the plant circuit in cases of emergency.

The Concord preparation plant is equipped with sufficient double units to make possible maintenance on operating shifts. Provision for almost any emergency is made, so full capacity operations will not be interrupted. Governors and electrical interlocks or both are provided for every unit of equipment in the plant whose operation depends on receiving the product from a preceding unit. This provision makes necessary the starting of equipment in proper sequence, while stoppage of any unit automatically stops all preceding units and prevents a plant choke-up. A central panel provided with warning and stop lights for all units controls the operation of the plant. All motors are totally enclosed and electrical equipment is watertight. This permits wash-down of all working places.

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Date-line Diary...

December 2

▲ Eastern railroads petitioned the ICC for an additional 4 per cent increase in freight rates. Request was made by 175 railroads which serve the area east of the Mississippi and north of the Ohio and Potomac Rivers.

December 4

▲ The Cleveland-Cliffs Iron Co. increased price of iron ore by 60¢ a ton.

▲ Based on reports of companies having 94 per cent of the capacity of the steel industry, the operating rate for the week beginning December 4 is scheduled at 100.5 per cent of capacity. This is equivalent to 1,938,400 tons of steel compared with 1,575,800 tons one week ago.

December 5

▲ Four subsidiaries of United States Steel Corp. raised mill prices of pig iron $3 a ton.

▲ Some operations of the Wheeling Steel Corp. at Wheeling, W. Va. were shut down because of flooding of the Ohio River.

December 6

▲ Flood waters at Wheeling Steel receded and operations were essentially back to normal.

▲ Engineering construction awards in November climbed to $1,012,000,000 a new high for the month.

▲ SKF announced a 5 per cent increase on all its ball and roller bearing products.

December 7

▲ Orders for new freight cars in November totaled 10,573 and deliveries totaled 5791. Backlog on December 1 was 126,870 compared with 122,148 on November 1st.

▲ Government raised price of general purpose synthetic rubber from 18½¢ to 24½¢ a lb. Butyl rubber was raised to 20.75¢.

▲ Price for ammonia was raised from $74 to $80 a ton.

▲ Don E. Ahrens, manager of General Motors, Cadillac division, predicted that car production in 1951 would be between 4,000,000 and 5,000,000 units.

December 8

▲ Wm. H. Harrison of the NPA stated that there would be no cutbacks in auto output and home building at the present time.

December 9

▲ The scheduled improvements for 1950-52 for the Jones & Laughlin Steel Corp. have been boosted to $228,000,000. This will raise ingot production 32 per cent in a little over a year.

▲ NPA revised limit on percentages of output which should be allocated to DO orders. The new ruling allows up to 100 per cent of total production for some items.

December 11

▲ Department of Commerce, as a result of a survey, estimates that outlays in 1951 for new plant and equipment will be $21,900,000,000 which will top the previous high record of $19,230,000,000 set in 1948. Expenditures for 1950 were about the same as the $18,100,000,000 spent in 1949.

▲ Based on reports from companies having 94 per cent capacity of the industry the operating rate for the week beginning December 11 is scheduled at 101.3 per cent of capacity. This is equivalent to 1,953,800 tons compared with 1,938,400 tons one week ago.

▲ Crucible Steel Co. signed the first union shop contract with the United Steelworkers under discussion in current negotiations. The first such contract was signed with Kaiser Steel Co. several years ago.

December 12

▲ The Chrysler Corp. and the CIO United Auto Workers agreed on a cost of living wage contract similar to that of General Motors and Ford Motor Co.

December 13

▲ The Aluminum Association reports that production of primary aluminum in October was 125,830,495 lb or 6 per cent above September. October shipments of sheet and plate totaled 108,170,099 lb, slightly under that for September.

▲ International Nickel Co. concluded wage negotiations at Sudbury, Ontario which increased wage rates 6½¢ to 8¢ an hr. As a result they raised prices of nickel. The new base price for electrolytic nickel in the United States is 50½¢ a lb. This new price is about 45 per cent above prewar prices.

▲ American Iron and Steel Institute reported that estimated total payroll of the iron and steel industry in October was $212,187,000 or the highest for any one month. Wage earners averaged 40.7 hrs a week, highest since 1945, and were paid an average of $1.726 an hr. Total estimated employment was 650,400.

▲ The British Iron and Steel Federation announced that November steel production reached the highest rate in history and was at an annual rate of 17,472,000 tons.

▲ The Electro Metallurgical division of Union Carbide and Carbon announced increases of some ferro-alloys about 1 per cent effective December 12.

▲ Allis-Chalmers Manufacturing Co. announced wage increases ranging from 10¢ an hr to 8 per cent for certain salaried groups.

December 14

▲ F. W. Dodge Corp. reports that construction contract awards in the 37 states east of the Rockies totaled $1,087,062,000 or 4 per cent less than October.

▲ Copperweld Steel Corp. has innovated a new billing system which uses a scrap price escalator clause.

▲ Henry Ford announced that the Ford Motor Co. plans to spend $1,000,000,000 in the next three years on plant improvements and expansion.

December 15

▲ Youngstown Sheet and Tube Co. announced pay increases of 11 per cent with a minimum of $22 a month for salaried employees earning up to $10,000 a year. Increases are retroactive to December 1.

December 16

▲ The Ministry of Supply of Great Britain announced that zinc will be rationed starting January 1.

▲ Steel operations in the Chicago area were hard hit by the railroad walkouts and freight embargoes.

December 18

▲ Based on reports from companies having 94 per cent of the capacity of the industry, the operating rate of the steel industry is scheduled at 100.8 per cent of capacity for the week beginning December 18, 1950. This is equivalent to 1,944,200 tons compared with 1,953,800 tons one week ago.

December 19

▲ The Agriculture Department announced that crops this year were the third largest in history, somewhat below 1948 and 1949.

December 20

▲ The NPA announced that tin use for non-military products will be cut 20 per cent starting February 1st. Steel plants are expected to use a thinner coating.

▲ Youngstown Sheet and Tube Co. announced that it will spend $90,000,000 at East Chicago to boost ingot capacity 20 per cent and pig iron capacity 15 per cent.

▲ The Aluminum Co. of America and United Steelworkers CIO signed a wage agreement.

December 21

▲ The Automobile Manufacturers Association predicted that passenger car production in 1950 would total 6,672,700 units. Total motor vehicle production was estimated at 8,015,750 units or 28 per cent above 1949.

December 22

▲ Edgewater Steel Co. purchased the Tracy Manufacturing Co.

▲ Rubber Manufacturers Association estimated that rubber use this year would total 1,240,000 tons.

▲ The American Zinc Institute reports that delivery of zinc in 1950 set an all-time record of 1,145,000 tons. Of this, United States smelters shipped 995,000 tons.

▲ The General Motors Corp. lifted its freeze on the sale of 1951 cars. They will be sold at December 1, 1950 prices. Thus the company gave in to the Economic Stabilization Agency freeze order.

December 23

▲ Chrysler Corp. was awarded a $160,000,000 tank contract; General Motors received a $100,000,000 contract for 2½ ton trucks; and the F. H. McGraw & Co. was picked to handle the $350,000,000 contract job at the new Uranium-235 plant at Paducah, Ky.

▲ The Economic Stabilization Agency froze auto workers wages at existing levels until next March.

December 24

▲ Motor vehicle registration in the United States reached a new high of 43,488,591 units on July 31.

December 25

▲ Merry Christmas.

December 26

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry the operating rate is scheduled at 100.1 per cent of capacity for the week beginning September 26. This is equivalent to 1,930,600 tons of ingots and castings compared with 1,944,200 tons one week ago.

▲ The nation's electric power and light industry set new highs in revenues and earnings according to preliminary estimates. Gross electric revenues should total $4,482,000,000 or 9 per cent above the previous high last year. Earnings should reach about $820,000,000 or 7.2 per cent above last year.

December 27

▲ Ohio State Board of Tax Appeals ruled that blast furnaces are personal property and not real property, as a result of a tax case filed by the National Tube Co.

▲ Aetna Standard is starting a $2,000,000 expansion program at its Ellwood City plant.

▲ American Petroleum Institute announced that crude oil production in the United States will total 1,973,000,000 bbl or 47,000,000 bbl below the record high of 1948. Petroleum production sales reached new high.

▲ Reliance Electric and Engineering Co. showed net earnings for the fiscal year ending October 31st of $1,676,004 or $8.37 a share, on net sales of $18,382,223.

December 28

▲ The AISC reported that bookings of structural steel for the month of November totaled 230,020 tons compared with 233,447 tons in October. November shipments were 154,640 tons and the backlog available for the next four months totaled 762,732 tons.

▲ United States Steel Co. announced that construction at their Morrisville plant will start in the spring of 1951. Ingot capacity will be 1,800,000 tons.

December 29

▲ The NPA prohibited hoarding of 55 essential materials, one of which was steel.

▲ Weekly electricity output topped 7,000,000,000 kwhr for the first time, in the week ending December 23rd.

▲ International Nickel Co. rolled back nickel prices for products produced in the United States by amounts running from ½¢ to 5¢ a lb. This rollback is in accord with the nationwide voluntary price freeze requested by the Economic Stabilization Agency.

December 30

▲ NPA put cobalt under complete company by company allocation.

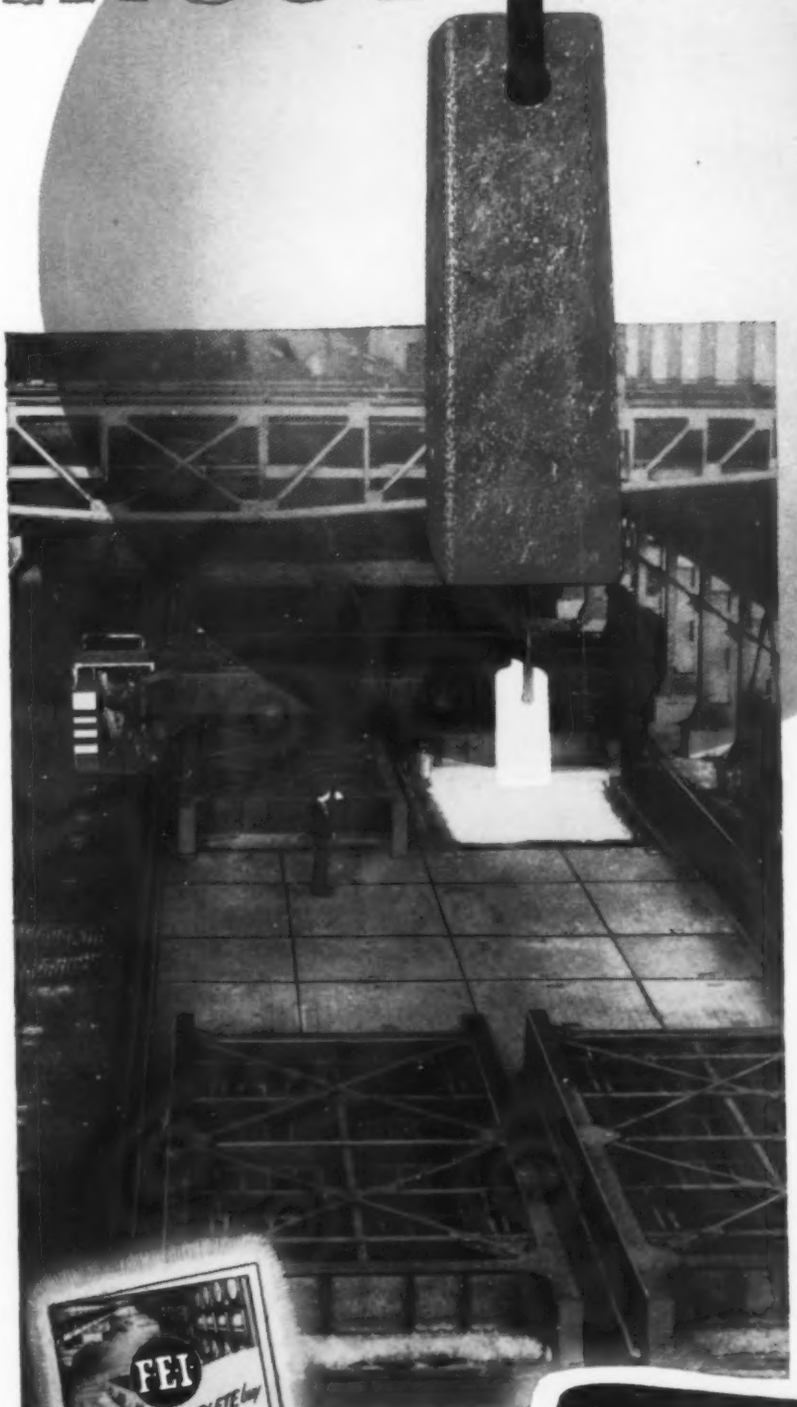
▲ The government ordered reactivation of three magnesium plants which should produce 112,000,000 lb in the next two years.

January 1

▲ Happy New Year.

The Complete Buy **F·E·I·** *for Greatly Improved*

INGOT HEATING



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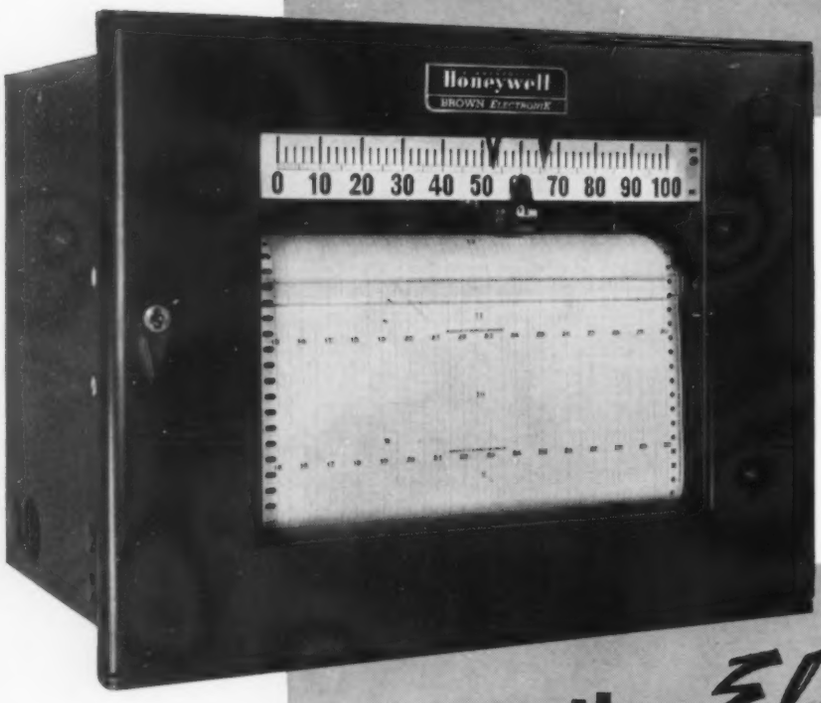

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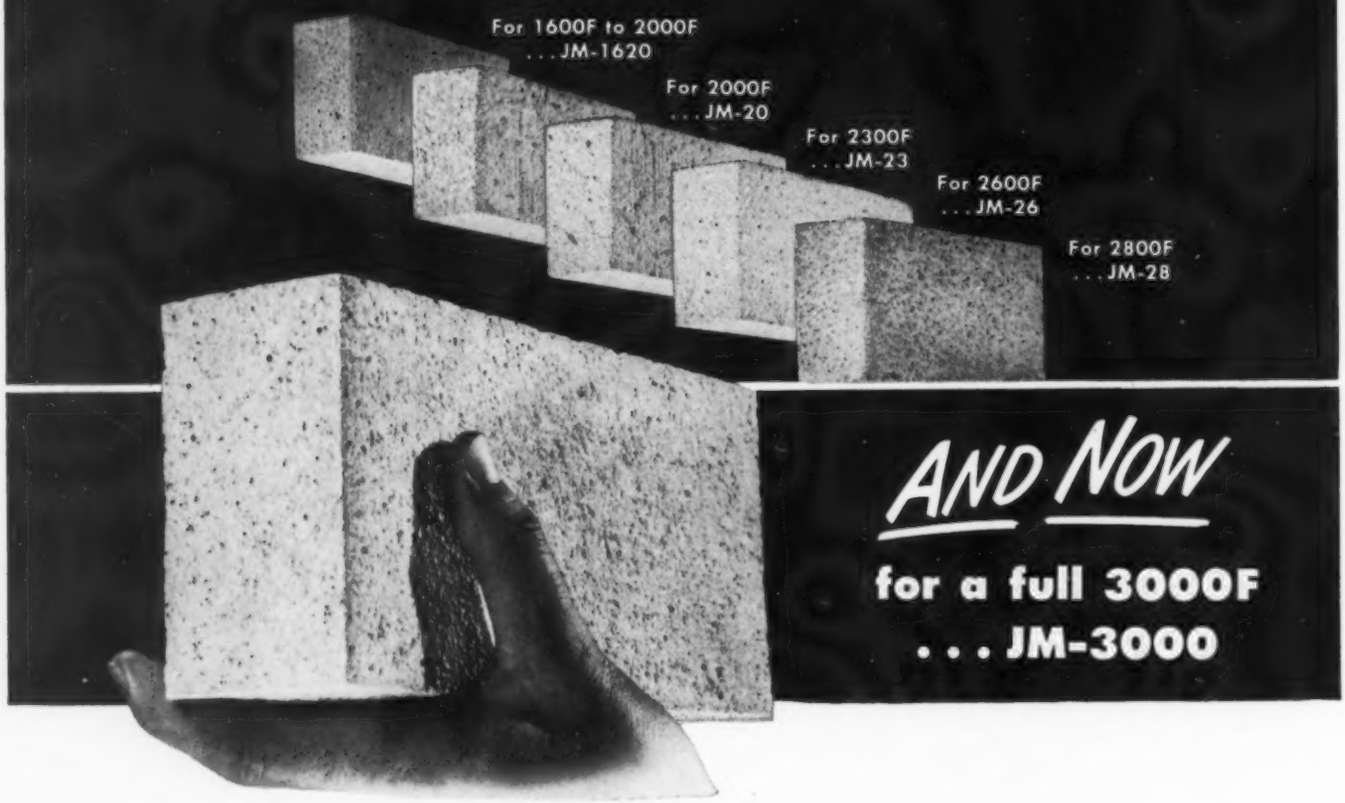

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By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

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	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† *24-hr simulative service panel test for JM-3000; 24-hr soaking period for other brick.*

* *Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.*

Note: Above tests are in accordance with A.S.T.M. tentative standards.

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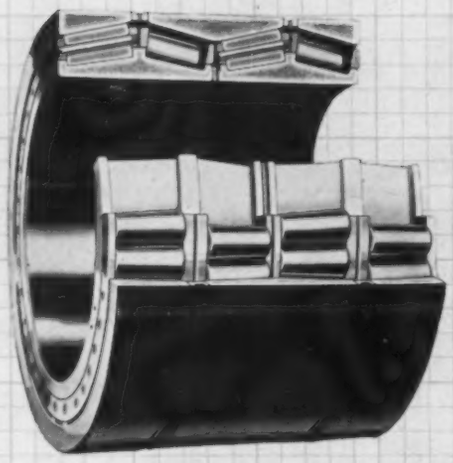

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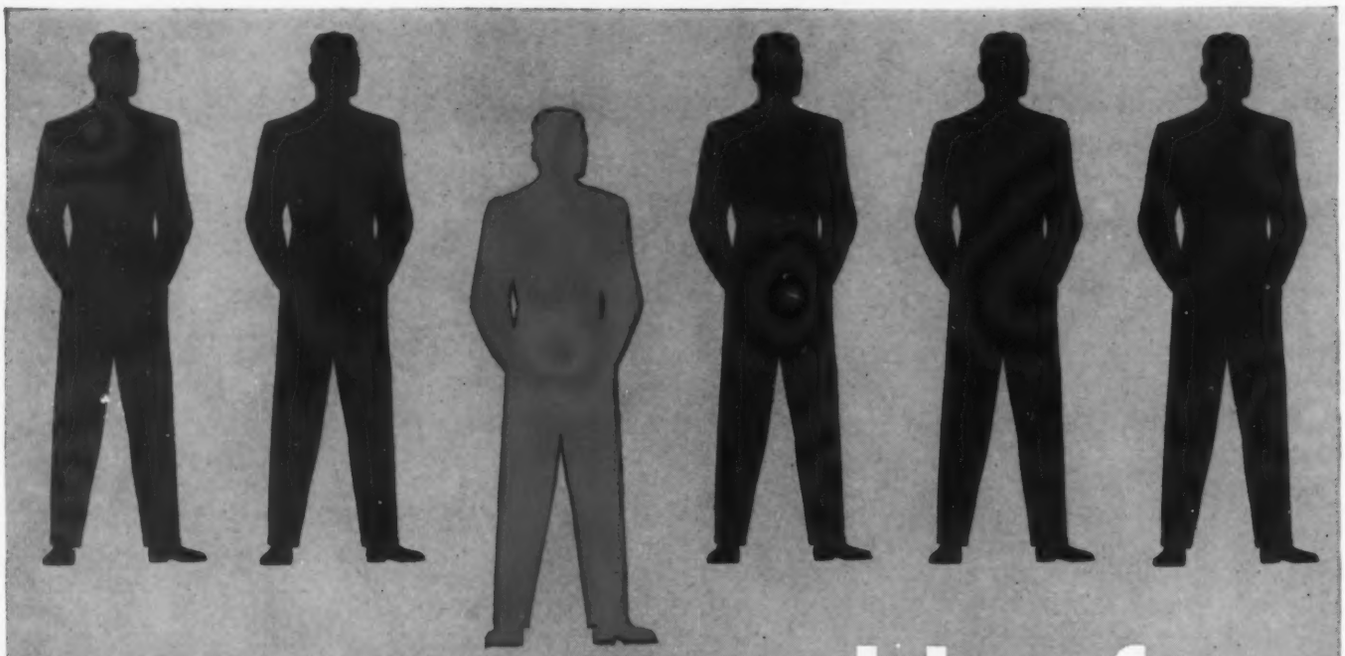

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Industry News...

FAIRLESS WORKS AT MORRISVILLE, PA. TO HAVE 1,800,000 TONS ANNUAL CAPACITY

▲ United States Steel Co. announced the details of what is believed to be the largest single expansion project ever undertaken by any steel company in the history of the nation — a new, wholly-integrated steel plant near Morrisville, Pa., which will have the capacity to produce 1,800,000 ingot tons of steel a year for national defense and essential civilian uses.

To be named the Fairless works, in honor of Benjamin F. Fairless, president of United States Steel, the new mill will start rising on the banks of the Delaware River, opposite Trenton, N. J., early next spring and is scheduled for completion by the end of 1952. Within six to twelve months after construction work begins the first finished steel products are expected to start rolling out of the plant, which, when completed, will produce a wide range of finished products, including bars, standard steel pipe, wire rods, hot and cold rolled sheets and strip, and tin plate.

Fairless works is the largest element in a defense expansion program, authorized by United States Steel since the outbreak of war in Korea last June, which upon its completion will add more than 4,000,000 tons to the annual steel capacity of U. S. Steel's various facilities. The natural area for distribution of the products of the Fairless works is the middle Atlantic and New England markets. Located on Tidewater, the new mill can also be used for export shipments.

Among the products which will be produced at Fairless works will be carbon high strength and alloy steel ingots, blooms, billets, slabs, bars, including bar sized shapes, rounds, squares, concrete reinforcing bars, wire rods, light plates, standard steel pipe, hot and cold rolled sheets and strip, vitrenamel sheets, black plate, electrolytic and hot dipped tin plate. It would also produce coal chemicals such as light oils, ammonium sulphate, crude naphthalene, and tar. Extensive defense requirements for these products exist throughout New England and in the industrial areas of New York, New Jersey and eastern Pennsylvania.

The Fairless works will have an initial annual capacity to produce 289,000 tons of cold rolled sheets, 235,000 tons of hot rolled sheets, 281,000 tons of standard pipe, 285,000 tons of bar products, and 170,000 tons of tin mill products.

Among principal facilities which will be erected at the new works will be a coke and coal chemical plant, including two 85-oven by-products coke batteries with an annual capacity of 916,000 tons of coke and additional tonnages of important coal chemical products; two blast furnaces with an annual capacity of 1,200,000 tons of pig iron; nine open hearth furnaces with an annual capacity of 1,800,000 tons of steel; an 80-in. hot strip mill and hot strip finishing facilities; finishing facilities for cold rolled sheets and tin plate; a bloom-slab mill and auxiliary facilities; a billet mill and auxiliary facilities; and a bar mill with a size range from ⅜-in. to 2-in.

National Tube Co., a subsidiary of United States Steel, will install facilities at this site for producing standard pipe, including a skelp mill, two Fretz-Moon continuous butt weld pipe mills to produce 281,000 tons of ½-in. to 4-in. butt weld pipe annually, pipe galvanizing facilities, and a warehouse of 30,000 tons capacity.

In addition to these basic facilities, the Fairless works will have a considerable amount of auxiliary equipment, including plant railways, roadways, sewers, utilities — including steam and electric power generation, laboratories, shops, and all industrial relations facilities. Among the major material handling facilities will be ore docks accommodating ocean-going vessels, unloaders, ore bridges and related equipment.

Upon completion, it is expected that the Fairless Works will employ about 4400 production workers, exclusive of the clerical and management staff.

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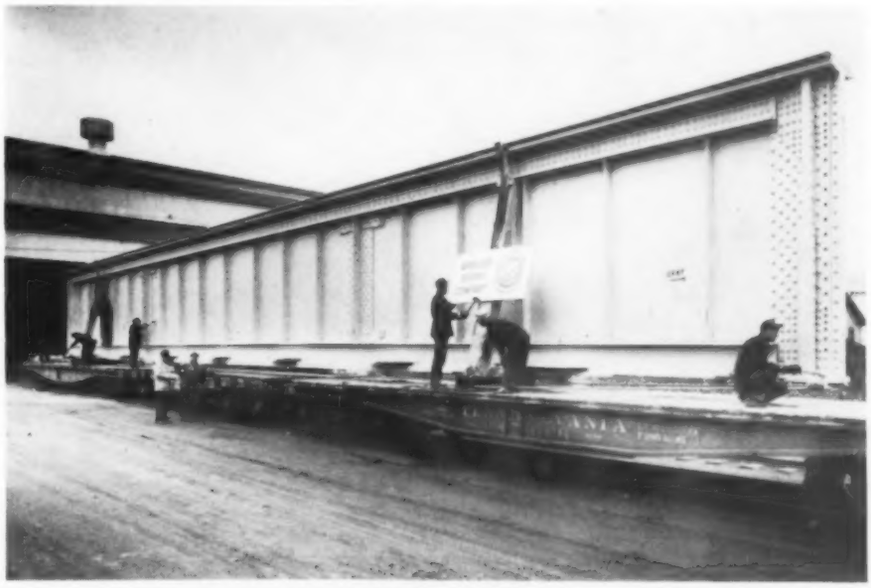
AMERICAN BRIDGE SHIPS 165-TON GIRDER



This 165-ton girder, one of the heaviest ever fabricated at the Ambridge, Pa., plant of U. S. Steel's American Bridge Co., is one of twelve for the crane runway in the new open hearth shop under construction at Jones and Laughlin Steel Corp.'s Pittsburgh works. Workmen at the American Bridge plant are shown getting the 110-ft giant ready for shipment.

The revolving breakers are 9 ft in diam and 14 ft long, with 2-in. round perforations in the shells. There are no fins as in conventional breakers, the grinding action of the rock being sufficient to reduce the coal to minus 2 in. The coal falls through the perforations to a 48 in. conveyor for transport to the blending bins. The rock is tumbled through the breaker and discharged to the single-roll crusher. The conveyor from the crusher is 36 in. wide, operates on 261-ft centers and travels 212 fpm. It discharges into a 150-ton bin. The crushed rock from the bin is loaded into 22-ton semi-trailer trucks for disposal on the dump area. The transfer conveyor from the vibrating screens and the revolving breakers is 48 in. wide, operates on 178-ft centers and travels 383 fpm on an 18-degree slope to the blending bins.

Coal from the blending bins is delivered through feeder gates mounted below each of the 24 pockets to eight feeder belts, each serving three pockets. The feeder belts, which discharge to the main collector belt, are 30 in. wide and operate on 43-ft centers at variable speed. The gates are air operated and only one gate of the three in each set can be opened at one time.

To make sure that the coal from the gates is moving, it is necessary to keep all eight belts under continual observation. To eliminate the constant walking involved in this patrol, a plant employee designed a simple wooden paddle to be mounted over each of the feeder belts. The blades of the paddle are turned as the coal passes under them. An observer from any point on the floor can now determine if the coal is moving simply by observing whether all the paddle wheels are in motion.

The main collector belt from the bins is 54 in. wide and operates on 525-ft centers at 435 fpm up a 20-degree slope. This belt carries the 2-in. by zero raw coal to a surge bin at the top of the preparation building.

From the 25-ton capacity surge bin, coal is removed by a feeder belt 72 in. wide, operated on 15-ft centers at variable speed. This belt delivers coal to a 60-in. drag conveyor operating on 94-ft centers. The flights of the drag conveyor are spaced at 3-ft intervals. This conveyor scrapes the coal over a series of five graduated openings, each of which permits coal from different areas of the flight to drop onto a vibrating screen for wet screening.

The five, double-deck vibrating screens are 6 by 16 ft, with $\frac{3}{4}$ in. square openings in the top deck. The bottom deck has $\frac{5}{16}$-in. square openings. There are four rows of water sprays on each screen, and oversize from both decks recombines and collects on a 42-in. wide conveyor for transport to a cone gravity separator.

The screen undersize and water containing 40 per cent solids are conducted to a primary distributor.

The gravity separator is 12-ft diameter cone where a sand-water medium separates the oversize from the vibrating screen into washed coal and refuse, in the proportions of one part washed coal to two parts refuse. The sand in the tank is kept in suspension by an agitator. A torque control on the agitator automatically opens butterfly valves for the removal of refuse.

The undersize pulp from the raw-coal sizing screens flows to a primary distributor, designed and built by Tennessee Coal, Iron and Railroad Company. This distributor is 9 ft in diameter and 9 ft high. It consists of a revolving top cylinder with seven outlets, three stationary compartmented bottom pans with four, five and six compartments and one bottom pan with seven compartments. The bottom pan will produce seven splits when held stationary, or eight splits when revolved. Arranged under the distributor are eight flumes fed by swivel spouts from the bottom pan. The primary distributor divides the $\frac{1}{4}$-in. by zero pulp into from two to eight parts, all parts being quantitative and qualitative equals. The number of splits can be changed without stopping the flow of feed. Each split flows to a secondary distributor for further division into feeds for the individual concentrating tables.

There are 64 concentrating tables consisting of eight sections of eight tables each. These are 8 by 16-ft diagonal-deck tables. Here the feed is separated into washed coal and refuse. The refuse flows to four drag dewatering tanks. Each serves two table sections. The refuse from these tanks is discharged to a 30-in. collecting belt conveyor. The water overflow passes to a 175-ft diameter thickener for further clarification.

The coal-bearing pulp from the tables is dewatered on eight 6 by 16-ft horizontal vibrating screens with $\frac{1}{2}$-millimeter stainless steel cloth. Each screen serves a section of eight tables. The dewatered oversize is collected on a conveyor while the fine coal and water slurry pass through the screen and flow to two hydroseparator tanks.

The water laden with solids passing through the dewatering screens is split to feed the two hydroseparators, which are 70 ft in diameter. They are concrete tanks, each equipped with an automatic rake-lifting device. Here the solids settle and thicken and are raked to the center. They are withdrawn and pumped back through a distribution tank to the dewatering screens to serve as a second layer. The hydroseparators make a separation of approximately 270 mesh. Materials below that size overflow with the water and go to the 175-ft thickener.

The dewatered washed coal from the concentrating tables and from the gravity separator is combined and conveyed to a 300-ton storage bin from which it is loaded into cars and shipped to the coke works. Refuse from the gravity separator and from the concentrating tables is combined and conveyed to a 300-ton storage bin, from which it is hauled to the dumping area.

Clarified water from the thickener is returned to the plant circuit. The use of fresh water for pump glands, wash-down hoses and spray nozzles supplies sufficient plant make-up water. A high outside wall on the thickener permits it to serve as a reservoir for all the water in the plant circuit in cases of emergency.

The Concord preparation plant is equipped with sufficient double units to make possible maintenance on operating shifts. Provision for almost any emergency is made, so full capacity operations will not be interrupted. Governors and electrical interlocks or both are provided for every unit of equipment in the plant whose operation depends on receiving the product from a preceding unit. This provision makes necessary the starting of equipment in proper sequence, while stoppage of any unit automatically stops all preceding units and prevents a plant choke-up. A central panel provided with warning and stop lights for all units controls the operation of the plant. All motors are totally enclosed and electrical equipment is watertight. This permits wash-down of all working places.

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Date-line Diary...

December 2

▲ Eastern railroads petitioned the ICC for an additional 4 per cent increase in freight rates. Request was made by 175 railroads which serve the area east of the Mississippi and north of the Ohio and Potomac Rivers.

December 4

▲ The Cleveland-Cliffs Iron Co. increased price of iron ore by 60¢ a ton.

▲ Based on reports of companies having 94 per cent of the capacity of the steel industry, the operating rate for the week beginning December 4 is scheduled at 100.5 per cent of capacity. This is equivalent to 1,938,400 tons of steel compared with 1,575,800 tons one week ago.

December 5

▲ Four subsidiaries of United States Steel Corp. raised mill prices of pig iron $3 a ton.

▲ Some operations of the Wheeling Steel Corp. at Wheeling, W. Va. were shut down because of flooding of the Ohio River.

December 6

▲ Flood waters at Wheeling Steel receded and operations were essentially back to normal.

▲ Engineering construction awards in November climbed to $1,012,000,000 a new high for the month.

▲ SKF announced a 5 per cent increase on all its ball and roller bearing products.

December 7

▲ Orders for new freight cars in November totaled 10,573 and deliveries totaled 5791. Backlog on December 1 was 126,870 compared with 122,148 on November 1st.

▲ Government raised price of general purpose synthetic rubber from 18½¢ to 24½¢ a lb. Butyl rubber was raised to 20.75¢.

▲ Price for ammonia was raised from $74 to $80 a ton.

▲ Don E. Ahrens, manager of General Motors, Cadillac division, predicted that car production in 1951 would be between 4,000,000 and 5,000,000 units.

December 8

▲ Wm. H. Harrison of the NPA stated that there would be no cutbacks in auto output and home building at the present time.

December 9

▲ The scheduled improvements for 1950-52 for the Jones & Laughlin Steel Corp. have been boosted to $228,000,000. This will raise ingot production 32 per cent in a little over a year.

▲ NPA revised limit on percentages of output which should be allocated to DO orders. The new ruling allows up to 100 per cent of total production for some items.

December 11

▲ Department of Commerce, as a result of a survey, estimates that outlays in 1951 for new plant and equipment will be $21,900,000,000 which will top the previous high record of $19,230,000,000 set in 1948. Expenditures for 1950 were about the same as the $18,100,000,000 spent in 1949.

▲ Based on reports from companies having 94 per cent capacity of the industry the operating rate for the week beginning December 11 is scheduled at 101.3 per cent of capacity. This is equivalent to 1,953,800 tons compared with 1,938,400 tons one week ago.

▲ Crucible Steel Co. signed the first union shop contract with the United Steelworkers under discussion in current negotiations. The first such contract was signed with Kaiser Steel Co. several years ago.

December 12

▲ The Chrysler Corp. and the CIO United Auto Workers agreed on a cost of living wage contract similar to that of General Motors and Ford Motor Co.

December 13

▲ The Aluminum Association reports that production of primary aluminum in October was 125,830,495 lb or 6 per cent above September. October shipments of sheet and plate totaled 108,170,099 lb, slightly under that for September.

▲ International Nickel Co. concluded wage negotiations at Sudbury, Ontario which increased wage rates 6½¢ to 8¢ an hr. As a result they raised prices of nickel. The new base price for electrolytic nickel in the United States is 50½¢ a lb. This new price is about 45 per cent above prewar prices.

▲ American Iron and Steel Institute reported that estimated total payroll of the iron and steel industry in October was $212,187,000 or the highest for any one month. Wage earners averaged 40.7 hrs a week, highest since 1945, and were paid an average of $1.726 an hr. Total estimated employment was 650,400.

▲ The British Iron and Steel Federation announced that November steel production reached the highest rate in history and was at an annual rate of 17,472,000 tons.

▲ The Electro Metallurgical division of Union Carbide and Carbon announced increases of some ferro-alloys about 1 per cent effective December 12.

▲ Allis-Chalmers Manufacturing Co. announced wage increases ranging from 10¢ an hr to 8 per cent for certain salaried groups.

December 14

▲ F. W. Dodge Corp. reports that construction contract awards in the 37 states east of the Rockies totaled $1,087,062,000 or 4 per cent less than October.

▲ Copperweld Steel Corp. has innovated a new billing system which uses a scrap price escalator clause.

▲ Henry Ford announced that the Ford Motor Co. plans to spend $1,000,000,000 in the next three years on plant improvements and expansion.

December 15

▲ Youngstown Sheet and Tube Co. announced pay increases of 11 per cent with a minimum of $22 a month for salaried employees earning up to $10,000 a year. Increases are retroactive to December 1.

December 16

▲ The Ministry of Supply of Great Britain announced that zinc will be rationed starting January 1.

▲ Steel operations in the Chicago area were hard hit by the railroad walkouts and freight embargoes.

December 18

▲ Based on reports from companies having 94 per cent of the capacity of the industry, the operating rate of the steel industry is scheduled at 100.8 per cent of capacity for the week beginning December 18, 1950. This is equivalent to 1,944,200 tons compared with 1,953,800 tons one week ago.

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▲ The Agriculture Department announced that crops this year were the third largest in history, somewhat below 1948 and 1949.

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▲ The NPA announced that tin use for non-military products will be cut 20 per cent starting February 1st. Steel plants are expected to use a thinner coating.

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▲ Rubber Manufacturers Association estimated that rubber use this year would total 1,240,000 tons.

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▲ Motor vehicle registration in the United States reached a new high of 43,488,591 units on July 31.

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▲ Based on reports from companies having 94 per cent of the steel capacity of the industry the operating rate is scheduled at 100.1 per cent of capacity for the week beginning September 26. This is equivalent to 1,930,600 tons of ingots and castings compared with 1,944,200 tons one week ago.

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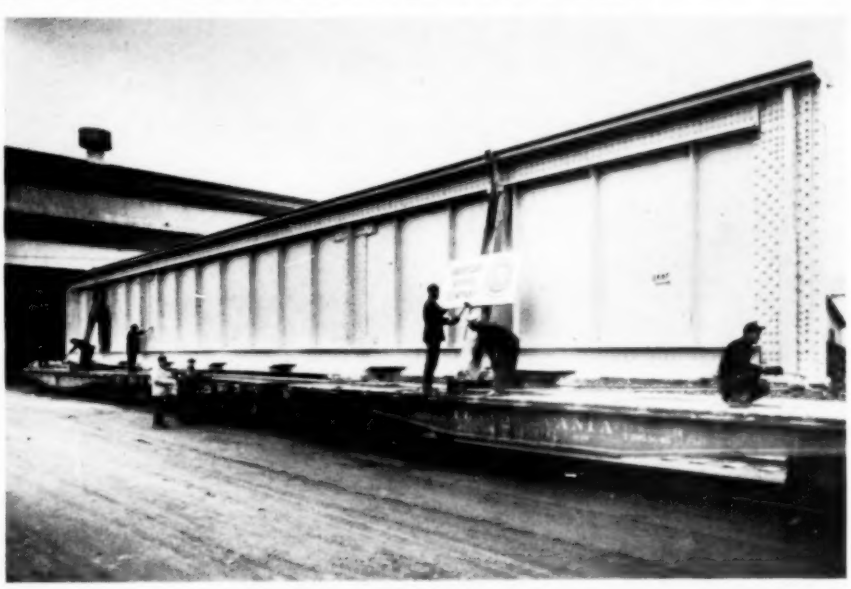

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Among principal facilities which will be erected at the new works will be a coke and coal chemical plant, including two 85-oven by-products coke batteries with an annual capacity of 916,000 tons of coke and additional tonnages of important coal chemical products; two blast furnaces with an annual capacity of 1,200,000 tons of pig iron; nine open hearth furnaces with an annual capacity of 1,800,000 tons of steel; an 80-in. hot strip mill and hot strip finishing facilities; finishing facilities for cold rolled sheets and tin plate; a bloom-slab mill and auxiliary facilities; a billet mill and auxiliary facilities; and a bar mill with a size range from $\frac{3}{8}$-in. to 2-in.

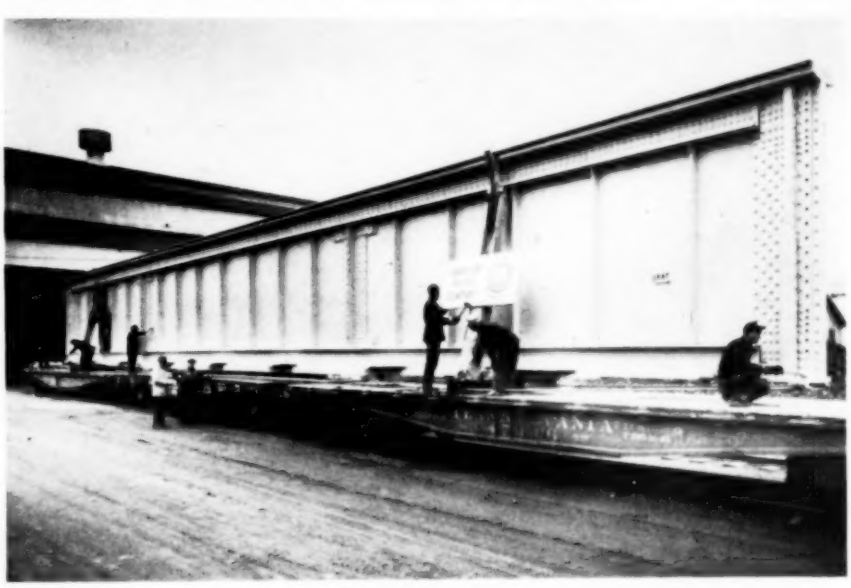
National Tube Co., a subsidiary of United States Steel, will install facilities at this site for producing standard pipe, including a skelp mill, two Fretz-Moon continuous butt weld pipe mills to produce 281,000 tons of $\frac{1}{2}$-in. to 4-in. butt weld pipe annually, pipe galvanizing facilities, and a warehouse of 30,000 tons capacity.

In addition to these basic facilities, the Fairless works will have a considerable amount of auxiliary equipment, including plant railways, roadways, sewers, utilities — including steam and electric power generation, laboratories, shops, and all industrial relations facilities. Among the major material handling facilities will be ore docks accommodating ocean-going vessels, unloaders, ore bridges and related equipment.

Upon completion, it is expected that the Fairless Works will employ about 4400 production workers, exclusive of the clerical and management staff.

National Tube Co. will operate the pipe producing portion of the new plant, while the remainder of Fairless

AMERICAN BRIDGE SHIPS 165-TON GIRDER



This 165-ton girder, one of the heaviest ever fabricated at the Ambridge, Pa., plant of U. S. Steel's American Bridge Co., is one of twelve for the crane runway in the new open hearth shop under construction at Jones and Laughlin Steel Corp.'s Pittsburgh works. Workmen at the American Bridge plant are shown getting the 110-ft giant ready for shipment.

experience
skill
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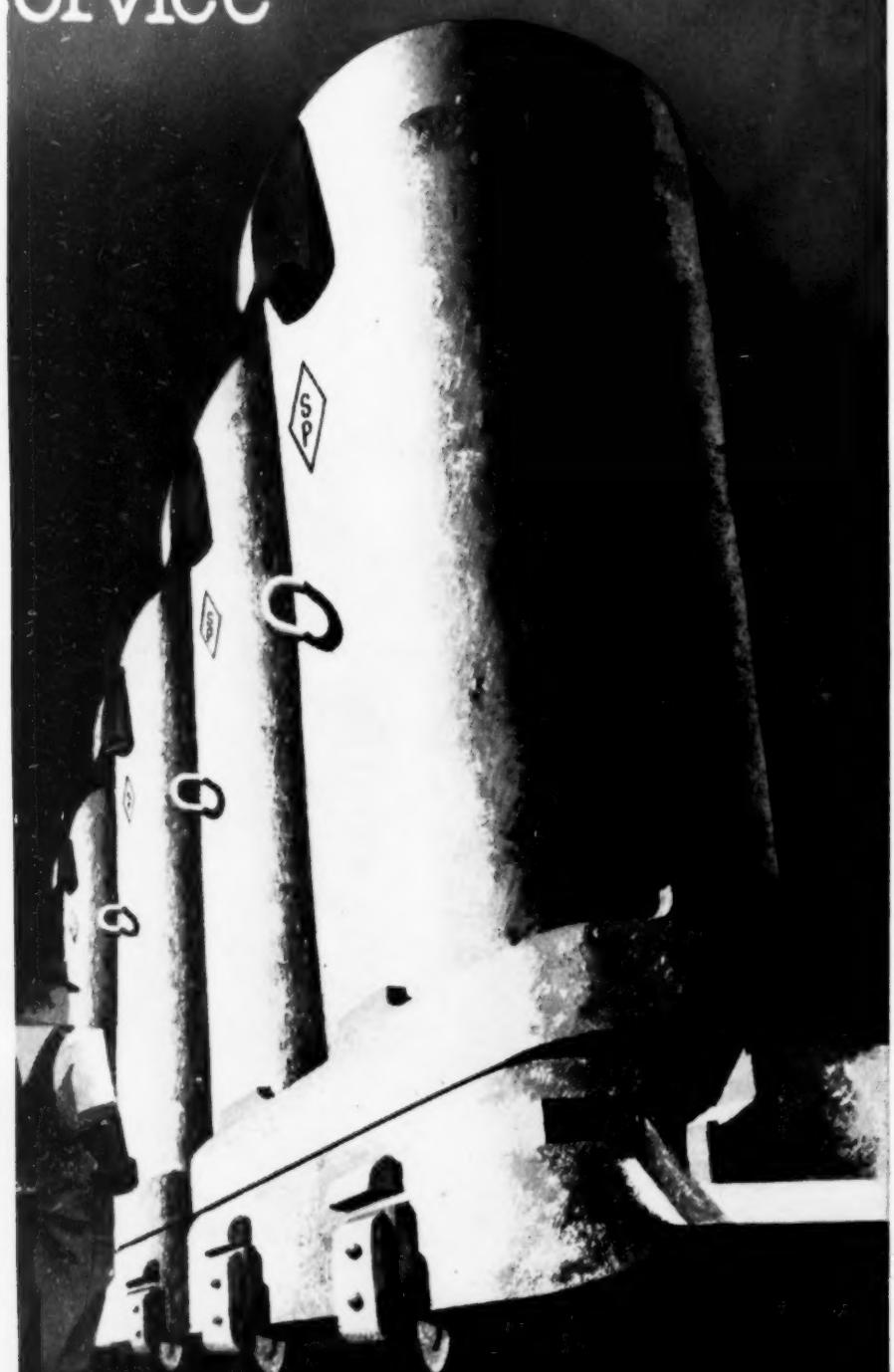

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behind every
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SHENANGO-PENN MOLD COMPANY OLIVER BUILDING PITTSBURGH, PENNA.

works will be operated by the newly formed United States Steel Co.

It is expected that the new plant eventually will utilize a part of the high grade iron ore which another United States Steel subsidiary, the Orinoco Mining Co., plans to mine from its iron ore properties in eastern Venezuela. Pending the availability of Venezuelan ore, the Fairless works will utilize other foreign ores as well as domestic iron ore.

BROSIUS AND SALEM ANNOUNCE MERGER

▲Merger of the Edgar E. Brosius Co., Sharpsburg, Pa., and the Salem Engineering Co., Salem, Ohio, also was announced. The new firm will be Salem-Brosius, Inc.

Ward A. Wickwire, Sr., and Sam Keener, presidents of Brosius and Salem, respectively, stated that both firms are "looking forward to an increase in their ability to serve the metal trades industries."

The merger will make Brosius production facilities available for fabrication of equipment designed by both firms.

NATIONAL STEEL BUYS LAND IN NEW JERSEY

▲ National Steel Corp. has purchased a tract including more than 2000 acres of land located on deep water of the Delaware River in New Jersey about 10 miles south of Camden, it was announced recently by Ernest T. Weir, chairman.

"The property has been acquired," Mr. Weir said, "for the construction of additional facilities to help meet the demands of National Steel Corp.'s continually growing business. The eastern plant will provide a very substantial tonnage of steel products for an expansion of our domestic distribution and also for the company's export trade."

Mr. Weir stated that plans are being developed to determine the lines of steel production to which the new plant will be devoted. No date has been set as yet for the start of construction.

National Steel Corp.'s present ingot capacity is 4,500,000 tons per year. A program of expansion now underway at various other National Steel operations will be largely completed early in 1952 and will increase the company's annual ingot capacity to

Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE
LOSS OF FUEL ECONOMY
BAD COMMUNITY RELATIONS

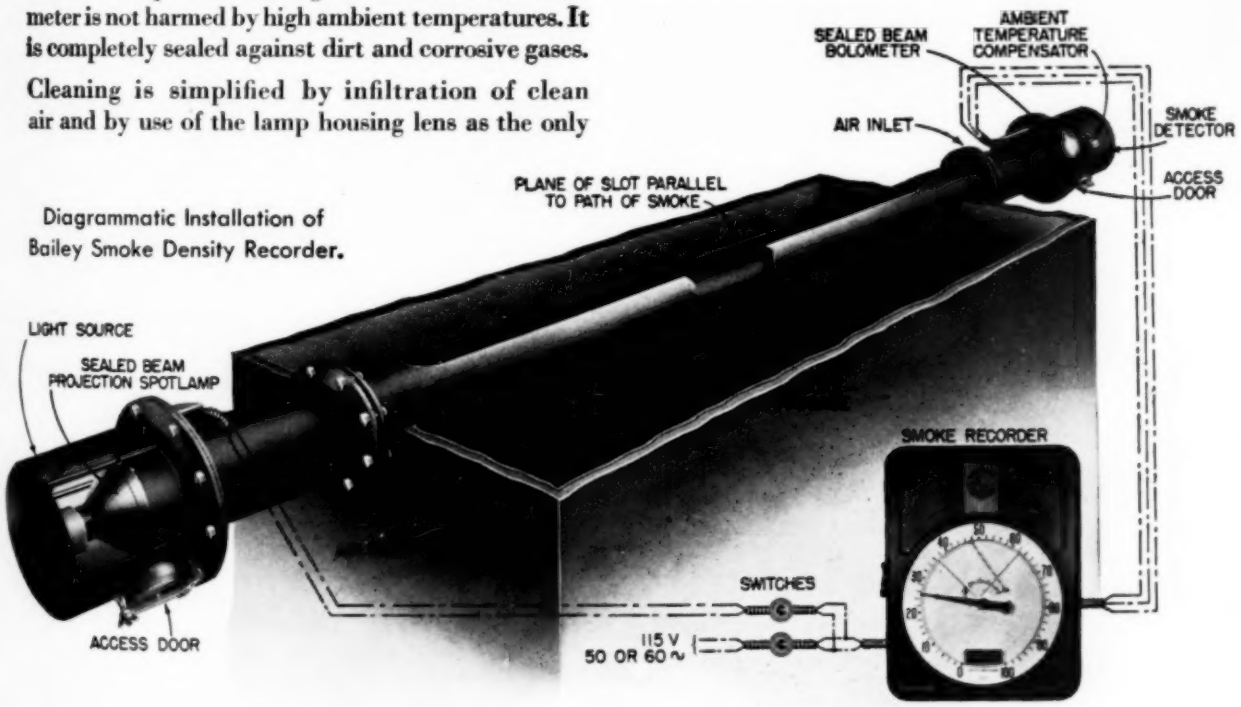
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

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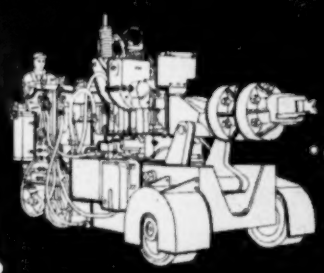
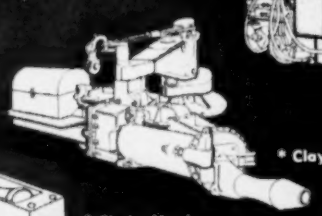
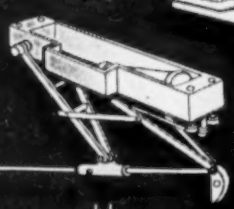


* Chargers and Manipulators



* Clay Guns



* Cinder Notch Stoppers

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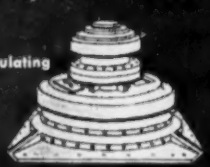

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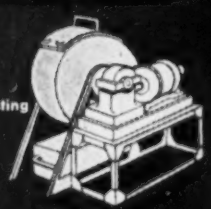

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5,500,000 tons. This total will be further increased by the capacity of the proposed new operation.

The deep water location of the eastern plant will afford transportation advantages for both inbound and outbound materials, since large ships will be able to berth at the plant's docks. Iron ore for the eastern plant's blast furnaces will be transported directly in ocean-going carriers from the new Labrador-Quebec iron ore field, in which National Steel Corp. is heavily interested.

TUBE PLANT SURPASSES ALL-TIME SAFETY RECORD

▲ The all-time safety record in the entire American steel industry was surpassed December 14 when Ellwood works of National Tube Co. reached 5,609,891 manhours of work without a single lost-time accident.

The plant's 3300 employes were on the job 318 days since anyone was kept from his job due to an accident at work. Best safety record previous to this in the steel mills of the nation was a total of 5,598,367 manhours at the Pueblo, Colo., plant of Colorado Fuel and Iron Corp., according to the records of the National Safety Council in Chicago.

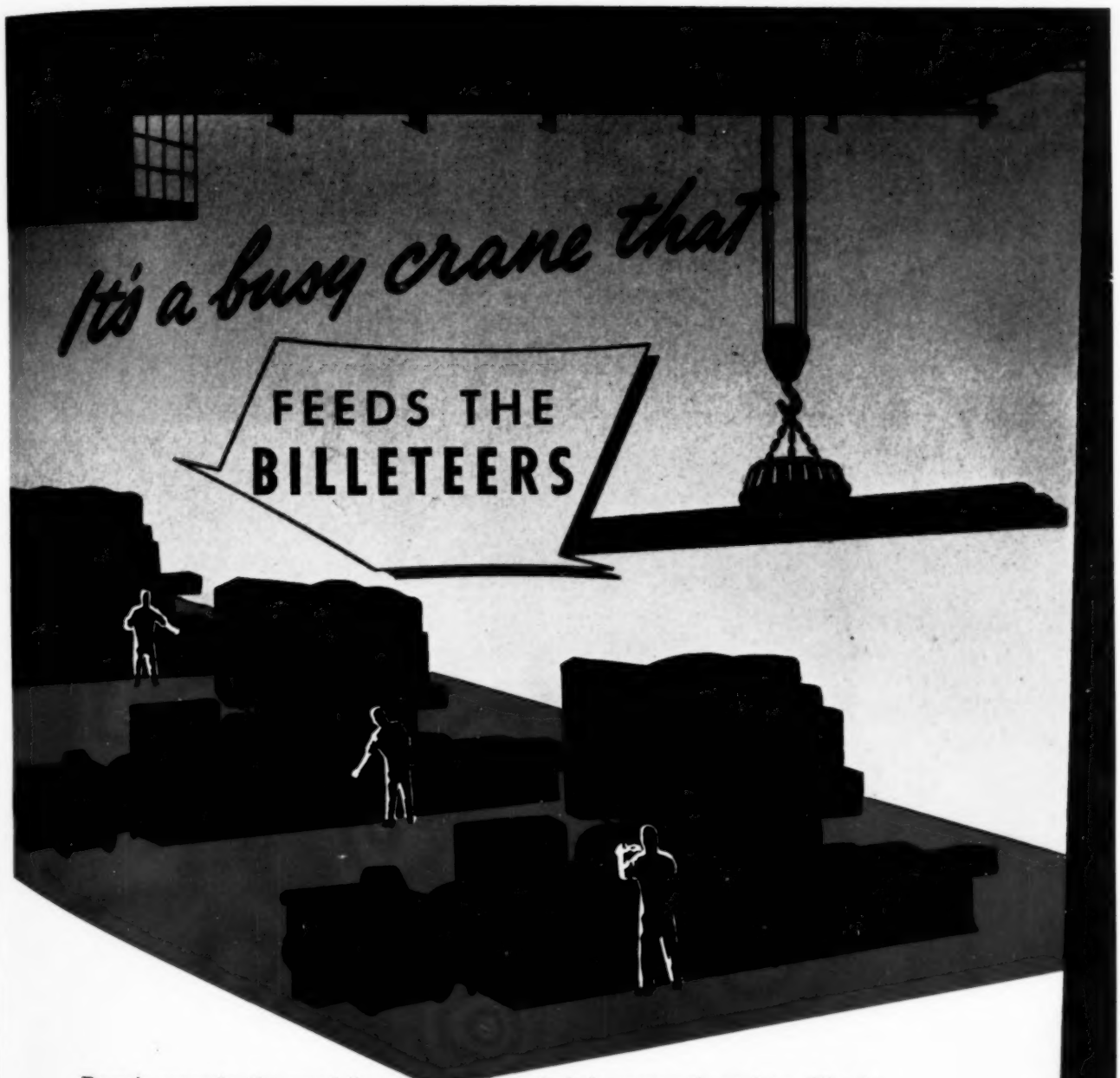
A workman suffered a broken toe from a falling piece of steel at the Ellwood plant January 29, 1950. He was off work two days. That was the last time there was a lost-time accident there.

TWO LIMESTONE FIRMS MERGE INTO SINGLE UNIT

▲ The merger of Pittsburgh Limestone Corp. and Michigan Limestone and Chemical Co., two existing subsidiaries of United States Steel Co., into a single operating subsidiary, effective on January 2, 1951, was announced by Benjamin F. Fairless, president of U. S. Steel. This merger is to effect a simplification of corporate structure within United States Steel. The merged company will retain the name of Michigan Limestone and Chemical Co.

New executive offices for the merged company are being established in the Guardian Building, Detroit, Mich. District operating headquarters will be continued at Rogers City, Mich., New Castle, Pa., and Buffalo, N. Y.

Irvin L. Clymer, head of both pres-



Busy is scarcely the word for steel plants and their cranes these days. They're being pushed to extra capacity! But regardless of demands, the Bonnot Billeteer produces to meet any and every emergency. For instance:

When **SPEED** is essential, actual tests on SAE 4150 steel show the Billeteer chips 49 times faster than hand chippers.

When **SAFETY** is considered, records show as many as 490,000 manhours without a disabling accident.

When **MANPOWER** is vital, Billeteers reduce manpower turnover — increase individual productivity.

When **COSTS** must be reduced, user records prove the Billeteer cuts cost as much as 50-60%.

Your Billet-Conditioning Problems Will Get Immediate Attention.

Engineered for Improved Production

The Bonnot Co.
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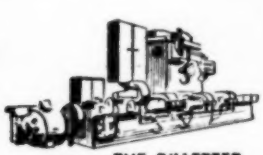
THE BILLETEER

ALSO MANUFACTURERS OF SAWING • CRUSHING • PULVERIZING & MIXING EQUIPMENT
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ent subsidiaries, will become president of the merged company. Other officers will be J. P. Kinville, assistant to president and treasurer; H. S. Lewis, vice president-operations; C. F. Platz, vice president-sales; H. R. Baltzerson, comptroller and assistant secretary; John G. Patterson II, secretary.

The present headquarters offices of Pittsburgh Limestone Corporation in the Frick Building, Pittsburgh, will be transferred principally to Detroit. Some departments will be transferred from Pittsburgh to New Castle.

BLAW-KNOX TO BUILD TONNAGE OXYGEN PLANTS

▲ Chemical Plants division of Blaw-Knox Co. has completed arrangements with the Linde Eismaschinen Co. of Germany, authorizing it to design and construct complete plants employing low temperature processes.

In making the announcement, E. W. Forker, in charge of Chemical Plants division, reports that among the important industrial processes made available by this arrangement, is one for the tonnage production of oxygen.

PORTER CO. ACQUIRES DELTA-STAR ELECTRIC

▲ H. K. Porter Co., Inc., Pittsburgh, Pa., following a policy of diversification of its manufacturing operations, has acquired the Delta Star Electric Co. of Chicago, Ill., manufacturers of high voltage electrical equipment, it was announced by T. M. Evans, president.

Delta Star Electric Co. designs and manufactures a variety of fittings, switches, insulators, conductors, supports and related equipment for the control and transmission of electricity around central power stations, substations and transformers. No change in the operations or management of Delta Star Electric Co. is contemplated, Mr. Evans stated.

In a little more than a year, Porter has expanded its operations into rubber, steel and electrical equipment by the acquisition of Quaker Rubber Corp., Connors Steel Co., and now Delta Star Electric Co. Mr. Evans stated that Porter will continue to expand and diversify its operations when a favorable opportunity presents itself. It is the policy of the company, he further explained, to diversify so as not to be completely dependent on any one industry.

SHEET AND TUBE EXPANDS AT INDIANA HARBOR

▲ An extensive expansion program has been announced by Youngstown Sheet and Tube Co. for its Indiana Harbor Works at East Chicago, Ind. The program includes:

A 75-oven battery of coke ovens with necessary coal handling, by-product and benzol facilities.

A 28-ft hearth-diameter blast furnace, complete with stoves, ore bins and gas cleaning equipment.

A 675-ft extension to the present ore yard and dock.

Two new ore unloaders.

One turbo-blower.

One steam boiler rated at 800 psi.

Additions to the water treating plant.

A new high back pressure turbo-generator.

Designed for specialized applications, the new Bloom HTR Burner will release up to 750,000 Btu per cubic foot of combustion volume. Exceptional results have been shown where quick heating and intense concentration of heat are required.

Write for Bulletin 1081 giving complete details.

New water intake tunnel and pump house.

Four new 250-ton open hearth furnaces in addition to the four-furnace unit now under construction.

Eight two-hole soaking pits with necessary cranes and auxiliaries.

One slabbing mill, complete with tables, shear and slab handling facilities.

New slab heating furnaces at the hot strip mill.

An extension to the strip mill finishing department.

With these expansions the company's coke capacity will be increased 430,000 tons a year, its pig iron capacity increased by 500,000 tons a year and its open hearth ingot capacity increased by 1,225,000 tons per year, including tonnage from the four open hearths now being built.

The company's bessemer steel plant will be discontinued with completion of the first four new open hearths, resulting in a net increase of 925,000 tons of steel ingots per year.

A substantial portion of these facilities is covered by certificates of necessity which have been issued by the National Security Resources Board.

OHIO WORKS TO ENLARGE NO. 5 BLAST FURNACE

▲ Blast furnace capacity at the Ohio works of United States Steel Co. will be increased by 112,000 tons a year with the rebuilding and enlarging of one of the plant's furnaces, it was announced by John W. Humphrey, superintendent of the plant. Installation at the same time of two new turbo-blowers will provide additional wind pressure for the operation of the plant's iron making furnaces.

No. 5 blast furnace will be shut down shortly after the first of the year for a complete overhauling and enlargement, which will increase its daily rated capacity by over 300 tons. Construction of a new building to house the turbo-blowers and auxiliary equipment is already underway. Work on the furnace and blowers is expected to be completed by next summer.

The new turbo-blowers will replace four obsolete, gas engine-driven blowers. Two of the existing boilers supplying steam for the furnace steam blowing facilities will be equipped with new coal pulverizers.

Work has also begun on a 1000-ft long underground supply line which will carry water to condense the steam used in the turbo-blowing operations. The chemically treated water will be continually recirculated and will be cooled in a specially designed four-cell cooling tower, now under construction. A concrete pump house and chemical storage building will be erected near the cooling tower.

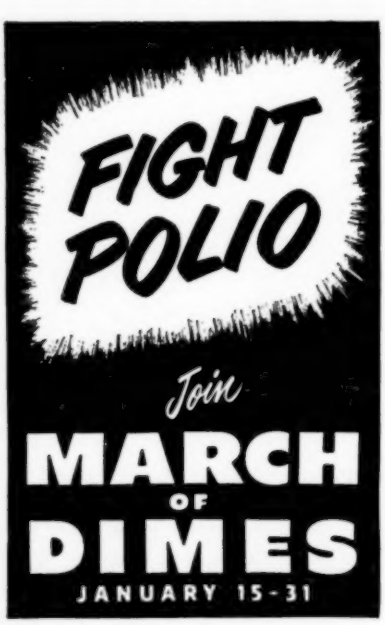
CARBON FIRM ADDS TO ELECTRODE EXPANSION

▲ National Carbon division of Union Carbide and Carbon Corp. has now announced plans for a further major addition to its electrode expansion project announced early in August, 1950. This addition will further increase its capacity for the production of graphite and carbon electrodes and the necessary facilities involved will be added to the present carbon electrode plant at Columbia, Tenn., to make it a completely integrated plant for the production of both carbon and graphite electrodes. Production from the new facilities is expected to begin by the middle part of 1951, and when completed by early 1952, will add many million pounds of graphite production annually as well as materially increase the production of carbon electrodes.

As a further part of the program to supply the electrodes to meet the fast growing demand for electric steel, important improvements are also being made at the Corporation Electrode Plants at Clarksburg, W. Va., and Niagara Falls, N. Y.

Company officials reveal that the largest graphite electrodes ever produced commercially — giants of 35 and 40 in. in diameter by 110 in. long — can for the first time be made in large quantity because of technical strides made possible through National Carbon research and engineering. The new large-size graphite electrodes will enable designers to develop electric furnaces with vastly increased power and capacity, or to step up power and capacity of existing furnaces where feasible.

Moreover, the Columbia Plant will go into mass production on other regular sizes such as the 20 by 72 in. graphite electrodes, and the large 35 and 40 in. carbon electrodes.



WESTINGHOUSE TO BUILD SMALL MOTOR PLANT

▲ Westinghouse Electric Corp. will build a new plant for the production of small electric motors in Union City, Ind.

The new plant will be a modern one-story structure containing both manufacturing and office space. When in full operation the plant will employ approximately 500 men and women. Production is expected to start late in 1951.

Plans were also recently announced for additional expansion of the Westinghouse small motor division in Lima. There two buildings, totaling some 120,000 sq ft of floor space, have been leased. The larger building will be used to produce machined parts needed at the company's main Lima plant for military production. The second building will be devoted to office and storage use. The division's industrial sales and industrial engineering departments now are located at this second site.

DUQUESNE TO INSTALL GAS CLEANING SYSTEM

▲ A second major step to control ferro-manganese smoke at Duquesne, Pa. works of United States Steel Co. was announced. The mill will install a new ferromanganese gas-cleaning system, designed for elimination of dust discharged from the furnace stacks and recovery of ferromanganese ore.

Final work is about completed on the first project in the plant's smoke control program, a bleeder stack to regulate pressure of ferromanganese gas from the furnaces. The 220-ft stack will be placed in operation soon. It will automatically control and burn

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AIR AND HYDRAULIC
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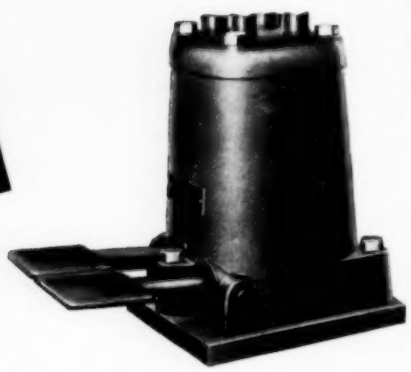

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Foot Valve

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Increase output of hammers, shears, presses, etc.

● Operators have both hands free to handle the work—speeding production. Valving mechanism has stainless steel body and push-pull rods, brass sleeves, self-sealing U-packers and many other refinements, all fully enclosed against dirt, assuring long efficient trouble-free operation. Convenient pipe connections. No metal to metal seating. ⅜" to 1" sizes, 3-way and 4-way, neutral position and regular actions. *Write for full details.*

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Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

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ferromanganese gas not burned in the plant's boiler houses.

The gas-cleaning system planned at Duquesne was designed by U. S. Steel engineers after an extensive study of blast furnace gas problems. It will be the first of its kind ever built. Smoke and dust will be removed from the ferromanganese gas. The facilities will occupy a half-acre of ground near the plant's blast furnaces.

In addition to the important job it will do in smoke control, the cleaning system also will provide a supply of clean gas for the plant's central boiler house. The floury manganese dust removed from the gas will be thickened and pressed into briquettes for recovering the contained manganese, one of the steel industry's critical raw materials.

J & L MINE TO GET NEW VENTILATING SHAFT

▲ A new ventilating shaft for Jones & Laughlin Steel Corp.'s Shannopin Mine near Bobtown, Pa., will be constructed by the shaft and tunnel department of Dravo Corp. The concrete-lined shaft with inside dimensions of 12 ft 6 in. by 35 ft will go down 175 ft.

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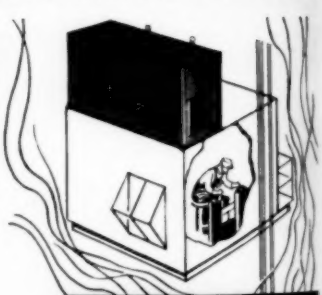

DRAVO CRANE CAB COOLERS

REPEAT ORDERS from steel, iron and non-ferrous metal producers offer proof of the outstanding results where Dravo Crane Cab Coolers reduce fatigue and improve operator performance. It's worth your while to call or wire Dravo for case history details of these applications.

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ARMCO BEGINS EXPANSION OF HOT STRIP MILL

▲ A $3,000,000 modernization program for the hot strip mill at Armco Steel Corp.'s East works began January 2. In anticipation of the shutdown of this department, Armco built up an inventory of hot rolled steel coils. This was made up of coils purchased by Armco customers from other steel producers which Armco will convert into finished sheets, along with a part of the normal accumulation of Armco's hot rolled production.

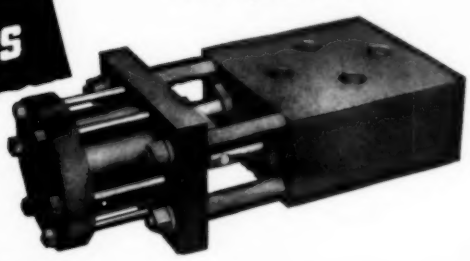
This inventory will insure a near steady supply of material all during the shut-down. As a result, all departments of the mill will work either full-time or at a somewhat reduced rate. The open hearth department will continue to produce ingots, storing them until the hot strip mill is back in operation.

In addition to providing this employment during the shutdown, the inventory of material will make it possible to continue full production of urgently needed steel during these critical times.

Personnel of the hot strip mill will work with maintenance and shop em-

Quick-As-Wink AIR AND HYDRAULIC Control Valves

¾ Inch 4-Way — 5000 p.s.i. Piloted Hydraulic Valve



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For hydraulic systems to 5000 p.s.i.

● Designed for controlling double acting hydraulic cylinders. The pilot cylinder is controlled by any type of 4-way air valve and is operated either automatically or manually from a convenient control station. Machined steel housing, hard chrome plated ground and polished stainless steel plungers, molded packers sealed by valve pressure. All parts readily accessible without disturbing the piping. ½" to 4" sizes. *Write for full details.*

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

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Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

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FREE Test Sample of the NEW FEL-PRO C-5 "HI-TEMP" THREAD COMPOUND

Eliminates Pitting of Stainless and Alloy Steels at all Temperatures!

CUT costly stud breakage, heater dismantling time, pitting of metal surfaces! We'd like to send you a free sample of the new Fel-Pro C-5 "Hi-Temp" Thread Compound to try on your toughest thread compound problems, including alloy and stainless steels. Then you can see the amazing, money-saving results being obtained by the nation's largest refineries, utilities and process industries. Fel-Pro's exclusive Colloidal-Copper formula keeps metal parts separated, regardless of temperatures. Its neutral action solves the alloy and stainless steel pitting problems. One utility company reports that heater dismantling time has been cut from two days to four hours, by the use of Fel-Pro C-5 "Hi-Temp". Why not see what "Hi-Temp" can do for you . . . get your free sample and complete data sheet—*write today!*

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- **FALCON COOLING PLATES**, both Bosh and Inwall—because they are made without those leak producing anchors and chaplets.
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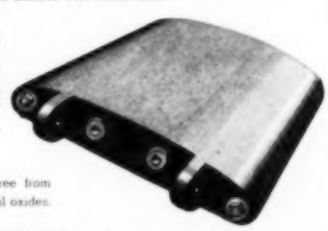

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ployees in making repairs. Although some of the men plan vacations at this time, there will be no lay-offs of hot strip mill men due to the repair work.

The new rolls and housings and other equipment which will be installed will be heavier than the present equipment. It is expected that this will result in an increase in production due to fewer delays and better yield. Quality should be improved because of the greater uniformity of product which the new equipment will make possible.

TRABON APPOINTS RITTER ENGINEERING

▲ Trabon Engineering Corp., Cleveland, Ohio, announces the appointment of the Ritter Engineering Co. of Pittsburgh, Pa., as exclusive distributor in the Pittsburgh district for the Trabon centralized lubrication systems. The new distributor will devote its full time and effort to the design, sale, installation and servicing of Trabon oil and grease systems on all types of industrial machinery.

Wayne G. Ritter, president of the newly appointed company, is a graduate of the Colorado School of Mines where he was a member of Beta Theta Pi fraternity and Tau Beta Pi, honorary engineering scholastic fraternity. After graduation he worked in the metallurgical and operating departments of the Youngstown Sheet and Tube Co. and in the engineering department of the Carnegie-Illinois Steel Corp. Called to the army in World War II, he rose to the rank of colonel, Engineers Corps, seeing service in the European theater. After cessation of hostilities he settled in Pittsburgh and was employed as a sales engineer with the F. R. Magill Co. and for several industrial companies, including Trabon. He is a registered engineer in the Commonwealth of Pennsylvania. The company is located at 3031 West Liberty Avenue, Pittsburgh, Pa.

NATIONAL TUBE INSTALLS LARGE EXTRUSION PLANT

▲ J. E. Goble, president of the National Tube Co. has announced that a large extrusion plant for the manufacture of high alloy seamless specialty tubes, as well as shapes and bars, will be installed at their Gary works, Gary, Ind. The application of the extrusion process on a commercial basis to the manufacture of seamless steel tubes is an innovation in this country.

It is expected that a substantial part of the production afforded by these new facilities will serve very important needs of the armed forces.

The facilities, which will be housed in an existing building at the plant, will consist of a 2500-ton hydraulic extrusion press and related facilities for the production of tubes ranging from one and a half inches to six and a half inches in diameter with wall thicknesses up to one-quarter inch and lengths up to sixty feet. The new installation will also be capable of producing various shapes and bars from one-half inch to four and one-half inches.

It is expected that the extrusion plant will have a capacity of approxi-

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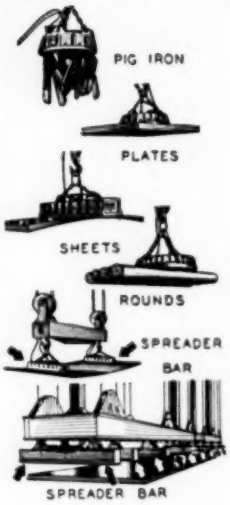

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mately 3000 tons of special tubes and shapes per month, and that the operation of the facilities should be possible before the end of 1951.

The recently developed French Ugine-Sejournet process for the hot extrusion of metals, using glass as a lubricant, will be employed in the operation.

CONNORS TO EXPAND IN BIRMINGHAM, ALA.

▲ Connors Steel Co. division, H. K. Porter Co., Inc. is proceeding immediately on a 40 per cent expansion of its steel making facilities in Birmingham, Ala. The new facilities will include additional electric furnace capacity, a breakdown mill, a heating furnace and increased finishing capacity. The company has secured the necessary approval from the National Resources Security Board to insure prompt completion of the program. It is estimated that total cost of the new facilities, when completed, will be approximately $2,000,000.

LEWIS RECEIVES ORDER FROM JAPANESE FIRM

▲ Lewis Foundry & Machine division of Blaw-Knox Co. has received an order from the Nichia Steel Works, Ltd., of Kobe, Japan, for rolling mill machinery and engineering services to form the nucleus of a modern continuous steel strip mill plant.

The new continuous plant will include eleven flat-rolling mills and four edging stands, plus auxiliary equipment. Lewis will supply seven mills, which includes a series of six 4-high finishing mills and one 2-high unit, plus auxiliaries. Lewis will also provide the design and complete engineering for the remaining mills, the edgers, and a full complement of mill accessories and related equipment.

The award to Blaw-Knox amounts to more than $1,000,000.

FOLLANSBEE TO MOVE PITTSBURGH WAREHOUSE

▲ Follansbee Steel Corp. is quadrupling its Pittsburgh warehouse space with the conclusion of arrangements for the purchase of a warehouse building on the south side of Pittsburgh, Pa. The disclosure came on the heels of an announcement that Follansbee was selling its old warehouse building in the downtown area to the Urban Redevelopment Authority, which is one of the agencies carrying out the Point Park program in Pittsburgh's Golden Triangle.

The South Side building had been occupied until recently by the Dilworth Porter division of Republic Steel Corp. and was used for the manufacture of railroad equipment. Its 100,000 sq ft represent an increase of warehouse space for the new tenant of approximately 300 per cent in area; volume will be increased by 600 per cent. Eight points for outgoing trucks will be available.

Also to be housed in the new quarters are the offices of Follansbee's warehouse division, as well as those of the Pittsburgh warehouse. Follansbee's general offices will remain in the downtown location. The move is scheduled to begin in March and to be completed in 30 days.

AIRCO BUILDS PLANT FOR EQUIPMENT MAKING

▲ Immediate construction of a new manufacturing plant of approximately 272,000 sq ft, on a 25 acre plot at Union, N. J., has been announced by John A. Hill, president of Air Reduction Co., Inc.

This new facility, providing for the employment of approximately 800 persons, will be used by the Airco equipment manufacturing division of Air Reduction Company, Inc., for the manufacture of welding and cutting torches, tips, regulators, oxyacetylene cutting machines, inert gas arcwelding machines, acetylene generators, oxygen and acetylene manufacturing and distribution equipment.

The plant, of brick and steel construction and all on one floor except for 18,000 sq ft of office space, will be located on property adjacent to the main line of the Lehigh Valley Railroad and within close proximity to U. S. Route 22 and N. J. State Highway 29.

L&N ACQUIRES MORE SPACE IN PHILADELPHIA

▲ Acquisition of approximately 85,000 sq ft of additional floor space by Leeds & Northrup Co., Germantown manufacturer of electrical measuring instruments, automatic controls, and heat-treating furnaces, has been announced by C. S. Redding, president of the 50-year-old firm. "This space," said Mr. Redding, "will enable us to increase our production and also improve our delivery and other service facilities. We will transfer some operations to this new space; however, the principal manufacturing and other activities of the firm will continue to be centered at the main plant, 4901 Stenton Avenue."

The added space is in two parcels. One is a 3-story, 50,000 sq ft building at Castor and Sedgley Avenues, leased from William D. Whitaker and formerly used as a spinning mill. The other property totals 35,000 sq ft at Collum and Rubicam Streets, Germantown, and was recently purchased by Leeds & Northrup for $92,500 from the Nathan Neuman estate. Together, they increase the company's Philadelphia floor space by 28 per cent, to a total of almost 10 acres.

U. S. STEEL REFIRES FURNACE AT ETNA, PA.

▲ Another old "war horse" of Pittsburgh district industry came out of mothballs at Etna, Pa., recently when U. S. Steel refired the No. 3 blast furnace at its Isabella plant.

Out of production since the summer of 1949, the old stack is being recalled to active duty to help meet the continuing unprecedented demand for steel. It will produce ferromanganese, an important steelmaking ingredient. The stack and two stoves have been completely relined.

BROWN INSTRUMENT ADDS TO MANUFACTURING SPACE

▲ Minneapolis-Honeywell Regulator Co. is expanding its industrial production and operating facilities in Philadelphia, Pa., according to Henry F. Dever, president of the company's Brown Instruments division.

The new expansion is made possible, Mr. Dever said, by the purchase of the Thomas M. Royal plant. The company has also acquired about 60,000 sq ft of undeveloped property in addition and adjacent to its new site, Dever added.

"It is already apparent that our present facilities are insufficient to permit production in line with demands which are being made upon us by the national mobilization program," Mr. Dever said. "We have the largest number of employees in Brown history. All signs indicate the whole industrial instruments industry, as well

as ourselves, will be asked to perform increasingly larger and more important roles in safeguarding the interests and principles of the accepted American way of living."

Honeywell's Brown Instruments division employment is nearing the 2000 mark, about 300 persons or 20 per cent more than during the World War II peak.

The building just acquired in Philadelphia is a three-story re-enforced concrete structure. It was partially occupied by Honeywell on December 15. Complete possession will take place in February.

LINK-BELT OPENS WAREHOUSE IN PITTSBURGH

This new Link-Belt factory branch store at 5020 Center Avenue, Pittsburgh, Pa., will provide industries in the Greater Pittsburgh area a convenient source of supply for power transmission and materials handling machinery. Ample space is available for complete stocks of popular Link-Belt products used so extensively in maintaining manufacturing efficiency.

ESTABLISH NEW FIRM FOR EXPORT TRADE

▲ The establishment of a new wholly owned company to carry on the foreign business of Electric Storage Battery Co. and its subsidiaries was announced by S. W. Rolph, president of the parent company.

Speaking as head of the newly organized firm, ESB International Corp., Mr. Rolph said, "Our overall objectives are to serve our customers in the foreign field in the best possible way and develop and extend our participation in world markets."

Incorporated under the laws of Delaware with authorized capitalization of $3,000,000, ESB International Corp.'s world-wide operations will be directed from new offices at 500 Fifth Avenue, New York City. The new corporation has taken over the export and foreign activities of Willard Storage Battery Co. and The Electric Storage Battery Co. in connection with Willard and Exide products.

RELIANCE FORMS CANADIAN COMPANY

▲ Establishment of Reliance Electric & Engineering (Canada), Ltd., of Welland, Ontario, as successor to the Commonwealth Electric Corp., Ltd., was announced by J. W. Corey, president, upon receipt of supplementary letters patent to this effect issued by the Secretary of State of Canada.

Control of this company which manufactures alternating current motors and transformers was acquired by Reliance Electric & Engineering Co., Cleveland, Ohio, in September, 1950.

Transformers and alternating current motors will continue to be manufactured and sold bearing the trade name Commonwealth. In addition, Corey said, the plant is taking on the manufacture of three Reliance lines, namely, all-electric, adjustable-speed drives for alternating current circuits, engineered drives and direct current motors.

Officers of Reliance Electric & Engineering (Canada), Ltd., elected at a recent meeting of directors are: J. W. Corey, president, J. N. Stanley and G. E. Bevis, vice presidents, and C. G. Kilty, secretary-treasurer.

Mr. Corey is also president of Reliance Electric & Engineering Co., Cleveland. Mr. Stanley and Mr. Kilty have been officers of the Canadian

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company since its founding in 1934. Mr. Bevis, until his present election as an officer, was district sales manager in Syracuse for Reliance, in charge of sales operations for northern New York State and Canada.

A 60 acre plot has been purchased in Euclid, Ohio, paralleling for 2000 ft the Nickel Plate Rail Road right of way immediately to the east of the Tapco plant near Babbitt Road, with access from Euclid Avenue in the 24700 block.

To cost in excess of $1,500,000, the project involves construction of a one-story building of 130,000 sq ft, similar in important essentials to a plant of approximately the same size built by Reliance in Ashtabula four years ago.

Completion of the new Euclid plant will permit a 100 per cent increase, it is estimated, in production of electronic controls, adjustable speed V*S drives and other electric motors and motor drives now being built in two smaller plants of Reliance on East 152nd Street.

Arrangements have already been completed, Mr. Corey said, to release these plants to the Clark Controller Co. whose plant they adjoin, just as soon as it is possible to move Reliance operations from them into the new plant.

Present Reliance plants on Ivanhoe Road in Cleveland will be retained as will the Ashtabula plant. Motor production will be further increased at all of them, particularly after the transfer of renewal parts manufacture to the new Euclid plant has been effected.

GREAT LAKES ORDERS NEW BLAST FURNACE

▲ Great Lakes Steel Corp. has awarded Freyn Engineering Co. a contract for the design and construction of a 480,000 ton-per-year blast furnace.

Approximately 1200 tons of coke, 2500 tons of ore, and 500 tons of limestone daily will be charged into the completely integrated furnace, which will be located near Great Lakes Steel's existing line of three furnaces at Zug Island in the Detroit River.

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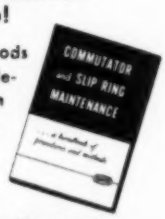

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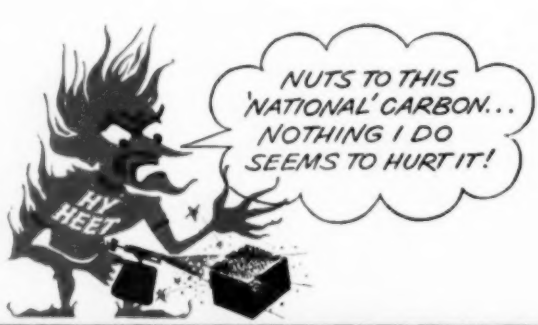

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Personnel News...

B. F. Fairless, as previously announced, became president of the newly formed United States Steel Co., Pittsburgh, Pa. on January 1, 1951. Other officials are as follows: **C. F. Hood,** executive vice president — operations; **D. F. Austin,** executive vice president — commercial; **R. M. Blough,** executive vice president — law and secretary; **M. W. Reed,** executive vice president — engineering and raw materials; **G. W. Rooney,** executive vice president — accounting; **F. R. Burnette,** assistant executive vice president — engineering; **B. S. Chapple, Jr.,** assistant executive vice president — commercial; **R. C. Cooper,** vice president — industrial engineering; **J. D. Darby,** vice president — sales; **R. W. Hyde,** treasurer; **C. A. Ilgenfritz,** vice president — purchases; **H. E. Isham,** assistant executive vice president — accounting; **S. M. Jenks,** vice president — manufacturing; **S. B. Kingham,** assistant executive vice president — accounting; **K. L. Konnerth,** vice president — coal division; **L. L. Lewis,** associate general solicitor; **J. E. Lose,** assistant executive vice president — operations; **E. E. Moore,** vice president — industrial relations administration; **L. M. Parsons,** vice president — Washington; **E. G. Plowman,** vice president — traffic; **B. L. Rawlins,** associate general solicitor and assistant secretary; **R. F. Sentner,** assistant executive vice president — commercial; **J. A. Stephens,** vice president — industrial relations; **G. M. Thursby,** vice president — industrial relations administration — coal division; **W. A. Walker,** vice president — accounting; **A. C. Wilby,** vice president — Chicago; **J. L. Young,** vice president — chief engineer; and, **R. E. Zimmerman,** vice president — research.

Robert Gregg will retire as president of the Tennessee Coal, Iron and Railroad Co., Birmingham, Ala. and will be succeeded by **Arthur V. Wiebel,** presently vice president in charge of operations. Also announced was the election of **John Pugsley,** now comptroller, to the newly established position of executive vice president. Succeeding Mr. Wiebel as vice president in charge of operations will be **J. M. Spearman,** who advances from the position of manager of manufacturing operations. Mr. Pugsley's successor as comptroller will be **Hartwell A. Greene,** presently assistant comptroller. Mr. Wiebel, the new top management official of TCI, came to the company in the fall of 1946 from Pittsburgh, where he was assistant to vice president in charge of engineering and operations, United States Steel Corp. of Del. On January 1, 1947, he became TCI vice president in charge of operations.

Edward J. Hanley has been elected president and **Clark W. King** was elected executive vice president of Allegheny Ludlum Steel Corp. Mr. Hanley, formerly executive vice president, will succeed **E. B. Cleborne,** who announced his resignation effective December 31, 1950. Mr. King, who is now vice president and treasurer, succeeds Mr. Hanley and will retain the position of treasurer. Mr. Cleborne will continue to serve the company as a director and vice president. The retirement on December 31, 1950, of **Frank B. Lounsberry** as vice president and technical director and the appointment of **W. B. Pierce,** presently manager of the company's sales development and engineering service department, as technical director were announced at the same time.

John J. Golden, former steel production division superintendent at the United States Steel Co.'s Gary, Ind., works, has been appointed assistant to vice-president in Pittsburgh, Pa. **Oscar Pearson** was appointed steel production division superintendent succeeding Mr. Golden.

Edward J. Gardner, formerly superintendent of blast furnaces and coke ovens for Inland Steel Co., Indiana Harbor, Ind., has been made assistant to the vice president, and will move to the Chicago, Ill., headquarters of the company. Operating departments of the plant have been divided into two groups. The primary operations and mills will be in charge of **Lee B. Luellen** as assistant general superintendent. The flat rolled departments will be under **J. Foster Mayberry** as assistant general superintendent. Mr. Luellen has been assistant general superintendent in charge of industrial relations since 1949. Mr. Mayberry was promoted from superintendent of the hot strip mills. **Theodore F. Plimpton,** formerly blast furnace superintendent, has been made assistant general superintendent in charge of industrial relations. **M. M. McClure,** superintendent of plant and community relations has

THUR V. WIEBEL

EDWARD J. HANLEY

JOHN J. GOLDEN

OSCAR PEARSON

been promoted to administrative assistant to the assistant general superintendent. **William A. Blake** was promoted to director of community relations reporting directly to the general superintendent. Mr. Blake was formerly superintendent of labor relations in which capacity he will be succeeded by **Ralph E. Hoover,** formerly superintendent of personnel. **James F. Peters,** formerly assistant superintendent of plant three blast furnaces, was made superintendent of blast furnaces. **William C. Kostbade,** assistant superintendent of the hot strip mills, has been made superintendent.

Alfred J. Castle has been transferred to inactive status by Inland Steel Co. under its retirement plan. Mr. Castle has been superintendent of the cold strip and tin mill departments of the company's Indiana Harbor, Ind., works. Also transferred to inactive status under the company's retirement plan were **Harry C. Barnes,** superintendentof the cold strip mill, and **Stuart A. Koegle,** superintendent of the tin mill, and both assistants to Castle in much of the development of cold strip and tin mill operations. **Henry N. Schumacher,** was named superintendent of the cold strip mill at Inland Steel Co., Indiana Harbor, Ind., and **William J. Walsh,** was appointed superintendent of its tin plate department. **John A. Keckich,** was transferred from the labor relations department to the cold strip mill as assistant superintendent.

Freeman H. Dyke has been named general manager of the properties of United States Metals Refining Co., a subsidiary of American Metal Co., Ltd. His headquarters will be in Carteret, N. J. Mr. Dyke was formerly with Compania de Acero del Pacifico, Concepcion, Chile, Wheeling Steel Corp., and Jones & Laughlin Steel Corp.

C. B. Allen, sales engineer in the Detroit, Mich., office of Reliance Electric and Engineering Co. for the past five years, becomes district manager in Buffalo, N. Y. heading up the work formerly handled from Syracuse by **G. E. Bevis,** now a vice president of the recently acquired Canadian division of Reliance at Welland, Ontario, Canada. **William H. Brehmer,** sales engineer in Buffalo while it was a branch office, moves to Syracuse to head branch operations there. Two sales engineers from Reliance's New York office will staff the newly opened office at 1060 Broad Street, Newark, N. J. **Elwood H. Koontz,** who joined the company in 1936 becomes the branch manager, and **F. R. Obenchain,** with Reliance since 1941, joins him as sales engineer. **R. C. Suttle,** sales engineer in the Cincinnati office for the past two years, has been made manager of the newly opened office at 202 Washington Ave., El Dorado, Ark. **W. C. McConnell,** who has been directing sales at the Reliance office recently opened in Charleston, W. Va., succeeds Mr. Allen in Detroit. **C. V. Harp, Jr.,** transferred from Houston, replaces Mr. McConnell at Charleston, W. Va., and **R. I. Coryell, Jr.,** sales engineer at Syracuse since last March replaces Mr. Suttle in Cincinnati, Ohio.

Robert L. Stanton was appointed assistant general manager of the wire rope division of Jones & Laughlin Steel Corp. at Muncy, Pa. Mr. Stanton joined the wire rope division in 1941 as an engineer. He was later appointed assistant to the general manager, the position he held at the time of his recent promotion. **George C. Peters,** former assistant superintendent of the safety and welfare department, Aliquippa works, has been appointed safety engineer for the corporation. Mr. Peters will work out of the office of the supervisor of safety and welfare in the Pittsburgh general office. **C. F. Seyler** was appointed project engineer—raw materials, to fill the vacancy created by the resignation of **H. R. Hughes.**

William Summerly has been appointed assistant to division superintendent, steel producing at the Duquesne, Pa., works of United States Steel Co. Mr.

WILLIAM SUMMERLY

Summerly was formerly general foreman at this plant.

Robert J. Flanagan was named assistant superintendent, blast furnace department, at Duquesne, Pa., works of United States Steel Co. Mr. Flanagan has been

ROBERT J. FLANAGAN

assistant to the superintendent, blast furnace department since 1948.

Fred C. Frame was appointed vice president of the Kidd Drawn Steel Co. of Aliquippa, Pa. Mr. Frame has been associated with the United States Steel Corp. for the past 15 years. In 1944, be became staff assistant to the sales vice president of Carnegie-Illinois Steel Corp.; and shortly thereafter transferred to the United States Steel Corp. of Del. as senior staff assistant to the vice president in charge of sales there.

M. D. Ayers is now chief engineer, Wheeling Steel Corp., Wheeling, W. Va. Until recently he was formerly

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with Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada, where he served as chief engineer.

Nils P. Johnson was appointed assistant to vice president—general services of Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Johnson has been chief accountant at the Pittsburgh works. It has also been announced that **W. S. McKee** will continue as assistant treasurer. **J. H. Donovan,** manager of credits, has been appointed assistant treasurer. **W. R. Oliver,** manager of collections, has been made an assistant treasurer. **G. R. Wilson,** assistant manager of credits, has been promoted to manager of credits.

W. C. Morgenstern, formerly chief engineer of Ellwood works, National Tube Co., Ellwood City, Pa., is now project engineer, Kaiser Engineers, Oakland, Calif.

J. S. Ahrens has been named manager of the carbon brush department of National Carbon Co.'s Cleveland, Ohio, office. Mr. Ahrens was formerly industrial sales engineer in the Birmingham, Ala., office.

Edward C. Kline was elected executive vice president and director of the newly formed E S B International Corp., wholly owned subsidiary of Electric Storage Battery Co. of Philadelphia, Pa. **John B. Clark** and **James E. Sheridan** were both elected as vice president and director of E S B International Corp.

EDWARD C. KLINE

Glen McDowell, formerly roll sales manager, Aetna Standard Engineering Co., has joined the roll sales force of the Lewis Foundry & Machine division of Blaw-Knox Co. Following are other changes at Lewis Foundry: **W. B. Hackett** has been appointed assistant to the president in charge of engineering. **C. W. Baker** has been appointed manager, contract engineering. **A. C. Fisher** has been appointed manager, sales engineering and service. **G. T. Andrews** has been appointed manager, machinery sales.

Emil R. Schaeffer has been appointed manager of manufacturing of the General Electric Co.'s switchgear divisions at Philadelphia, Pa. In 1948 he was appointed assistant to the manager of manufacturing, the position he held until his present appointment.

Charles L. Hardy has been elected president of Joseph T. Ryerson & Son, Inc., Chicago, Ill., taking the place of **Everett D. Graff** who will become chairman of the executive committee at the same date. **Thomas Z. Hayward** was elected vice president in charge of

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Integrated High Capacity Heat Treating Lines featuring the Pressure Quench...produces ***FLAT*** *high quality Plate*

Continuous, oil or gas fired Roller Hearth Furnaces for hardening and tempering both face hardened and homogeneous armor plate. Also Carburizing Furnaces and Car Type Furnaces for heat treating. Whatever your specific problem, consult DREVER.

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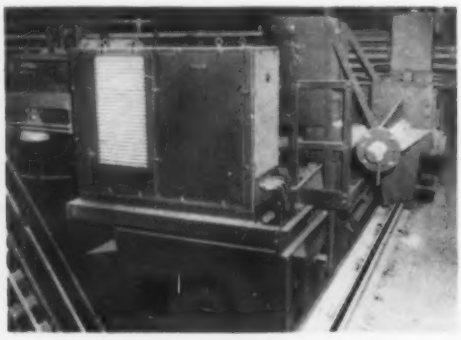
compact, efficient
LINTERN AIRE-RECTIFIER
requires but little space

1.

THIS IS THE CAB (6' x 6'), in a large modern plant, which has been air conditioned with a Lintern Aire-Rectifier. The operator does his work with ease and accuracy in temperatures of 70°-80° — even on the hottest days when working over the hottest spots.

2.



THIS IS THE CONDENSER UNIT located on cantilever beams over door of the cab — out of the way, and offering no interference with operations. (Can be located wherever desired). It is connected by means of refrigerant lines to the Cab Unit.

3.

THIS IS THE CAB UNIT. It takes only 3 square feet of space and fits easily at the rear of the cab. The operator has plenty of room. It contains the cooling (evaporator) coil, electric heater for winter use, screen type and activated carbon filters. It also includes automatic thermostats and switch for operating the equipment.

The Lintern Aire-Rectifier is a marvel of compactness and efficiency. May we send you the complete story?

THE LINTERN CORPORATION

29-2 RIVERSIDE DRIVE • BEREA, OHIO

sales. Both Messrs. Hardy and Hayward were elected as directors and members of the executive committee.

Ralph J. Cordiner, has been elected president of the General Electric Co. to succeed **Charles E. Wilson,** recently named as chairman of the new Defense Mobilization Board. Mr. Cordiner, who has been associated with General Electric for 24 years and has served as manager of five of the company's departments during that period, has been executive vice president and a director of the company since 1949. He assumes his new duties immediately.

Casimir S. Kopec has joined the staff of the American Gear Manufacturer's Association as staff engineer. Mr. Kopec will devote full time to the development of the Association's technical literature.

N. W. Landis has been named manager of Allis-Chalmers' Detroit, Mich., district office succeeding **F. S. Schuyler,** who is retiring after 43 years of service. Mr. Landis had been manager of the company's Syracuse office since 1946. **A. J. Mestier, Jr.,** a sales representative in Allis-Chalmers' New York district office since 1948, succeeds Mr. Landis as manager at Syracuse, N. Y.

Alexander Zeitlin was appointed as vice president

ALEXANDER ZEITLIN

of Hydropress, Inc., N. Y. and Loewy Construction Co., Inc., N. Y.

Edward Salner was named manager of the precipitator department of the metal products division of Koppers Co., Inc. Mr. Salner succeeds **Frank H. Linthicum,** who died on December 11, 1950.

Paul E. Young has been appointed director of purchases at Timken Roller Bearing Co., Canton, Ohio, succeeding **Dwight A. Bessemer** who was named assistant to the president recently. **R. J. Archibald** has been named assistant general purchasing agent.

C. Carlisle Tippit, manager of the order and planning department of Reliance Electric & Engineering Co. since January, 1948, has been appointed general purchasing agent of the firm. **Walter H. Behnke,** in Reliance's applied engineering department since 1945, has been selected to take over Mr. Tippit's former duties.

Charles E. Newman has been appointed sales engineer for the Chicago, Ill., territory by Surface Combustion Corp.

Stephen Godleski was appointed open hearth foreman for the United Engineering & Foundry Co.,

High Strength

for reduction of

STAINLESS, HIGH SPEED and AIRCRAFT QUALITY STEELS

BIRDSBORO 50 ROLLS

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● Extremely strong and tough, Birdsboro 50 Rolls have the physicals needed for blooming, cogging and roughing hard-to-handle yet rollable high-percentage alloy type steels—Aircraft Quality, Stainless and High Speed Steels.

These rolls are specifically designed for the jobs they have to do—"custom-built" to your specifications. If you have had any trouble rolling billets and ingots of these "temperamental" steels—get in touch with our roll engineers. They can show the way to increased output at low cost with Birdsboro 50 Rolls.

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DESIGNERS and BUILDERS OF:
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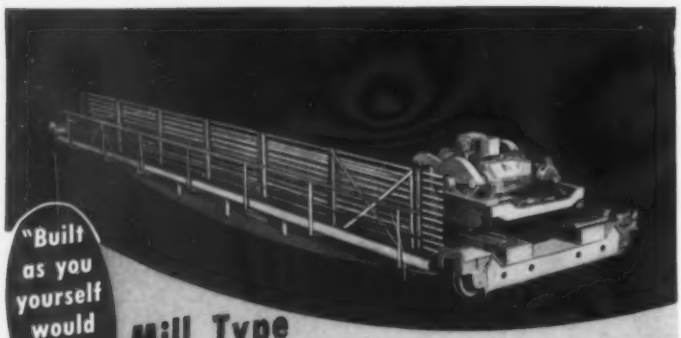

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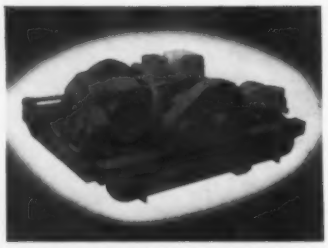

Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

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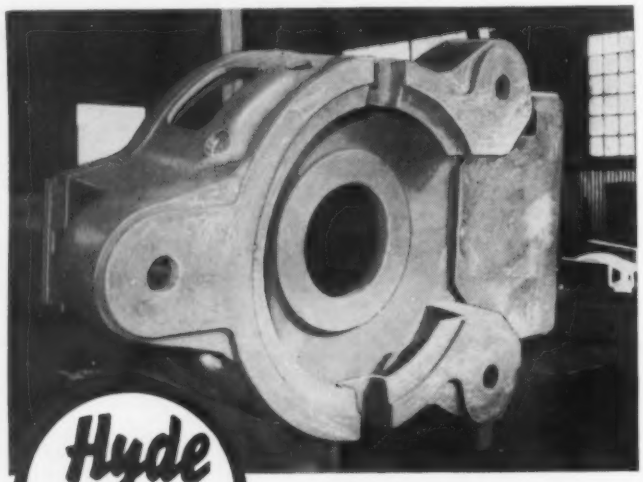
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes



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Up to 80,000 Pounds

for Steel Mills and Heavy Machine Tools

CHILLED and ALLOY IRON ROLLS
ROLLING MILL MACHINERY

INQUIRIES INVITED

HYDE PARK FOUNDRY & MACHINE CO.

HYDE PARK, PA. (PITTSBURGH DISTRICT)

Vandergrift, Pa. He succeeds Claude C. Meyer, who retired after 41 years service with United.

Gordon Fox, Harry Naismith and **W. B. Clemmitt,** were appointed divisional vice presidents in the engineering and construction division of Koppers Co., Inc. All have been affiliated with Freyn Engineering Co., a wholly-owned subsidiary of Koppers, or Freyn's subsidiary, the Open Hearth Combustion Co. Under action of the Koppers board of directors, Freyn ceased to be a company subsidiary and became a department of Koppers Engineering and Construction division. Activities of the Freyn department will be under the direction of W. C. Snyder, Jr., vice president and manager of the metallurgical department of the Engineering and Construction division. The new Koppers department will continue to have offices in Chicago and no other changes in organization or operation are contemplated.

Walter K. Grant has been appointed chief electrical engineer of Continental Foundry and Machine Co.'s rolling mill and special equipment division in Pittsburgh, Pa. Formerly with United Engineering and Foundry Co., Mr. Grant went to England in 1936 to

WALTER K. GRANT

assist in the construction of hot and cold strip mills for Richard Thomas Co., Ebbw Vale. After completion of the mills he remained in England for several years as chief electrical engineer of the Thomas Co., then returned to the United States in 1942.

Dr. George W. Vinal has been named engineering consultant and adviser to Electric Storage Battery Co., Philadelphia, Pa.

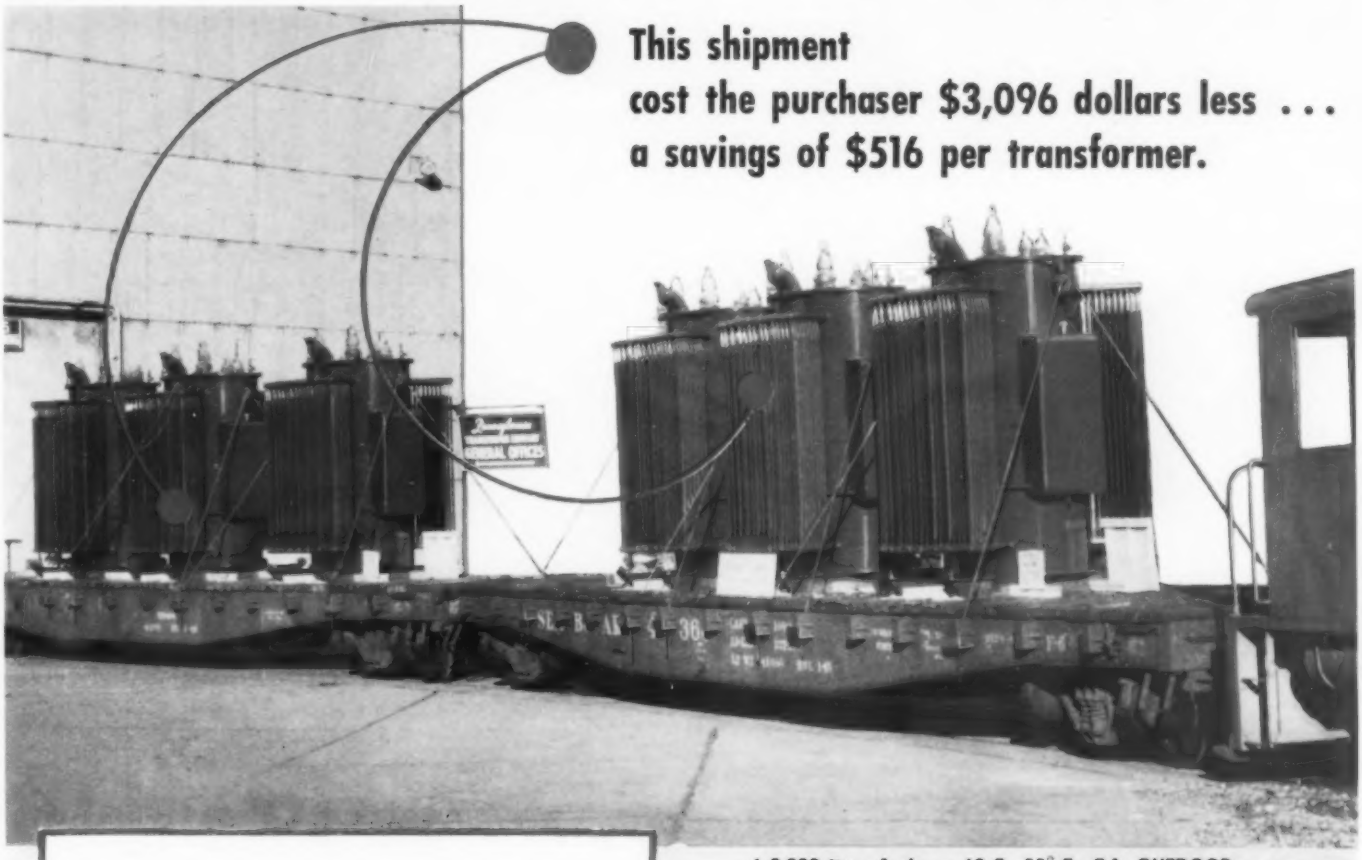
Robert A. Miller has been appointed sales manager, gear coupling division, Sier-Bath Gear & Pump Co., Inc., North Bergen, N. J.

A. C. Kukral will be the resident sales engineer for Whiting Corp. at Cleveland, Ohio, under the supervision of H. E. Reynolds, district manager at Pittsburgh, Pa.

Charles A. Berlepsch was appointed to the newly created post of director of purchases for Rockbestos Products Corp., and **Raymond B. Miniter** was named as purchasing agent.

Ray A. Bland has joined the sales engineering department of Sutton Engineering Co., Bellefonte, Pa. Mr. Bland was formerly employed in the sales department of United Engineering and Foundry Co., Pittsburgh, Pa.

You pay LESS for Pennsylvania Standard Parts Power Transformers



This shipment cost the purchaser $3,096 dollars less . . . a savings of $516 per transformer.

6-2,000 Kva, 1 phase, 60 C., 55° C., OA, OUTDOOR, — H. V. : 13,800 Volts.
Full capacity taps for 14,400, 14,100, 13,500, and 13,200 volts. — L. V. : 2400 4160Y Volts.
Inert gas — oil seal.

WHY

Standard Parts Power Transformers Can Be Sold For Less

Standard Parts Power Transformers can be purchased at worthwhile savings because of quantity production of standard parts produced with adequate tools and equipment. This has improved the quality of the workmanship, reduced the possibility of errors, and permitted more rigid inspection during the various stages of production. These factors, together with reduced production time, have shown a cost saving which has been passed on to the user.

A considerable amount of money was saved in the purchase of these transformers because the purchaser's requirements — mechanical and electrical — fitted into Pennsylvania's Standard Parts Power Transformer program.

Standard Parts Power Transformers are single phase transformers in sizes up to 5,000 Kva, 69 Kv; and three phase transformers in sizes up to 10,000 Kva, 69 Kv, which have standard or optional voltage ratings and standard or optional accessories. The type of oil preservation method familiar to the purchaser's operating personnel is supplied on these transformers — gas-oil seal, sealed tank, inert gas pressure, or expansion tank system.

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

Canonsburg, Pennsylvania — Greater Pittsburgh District

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1. Ore Bridges
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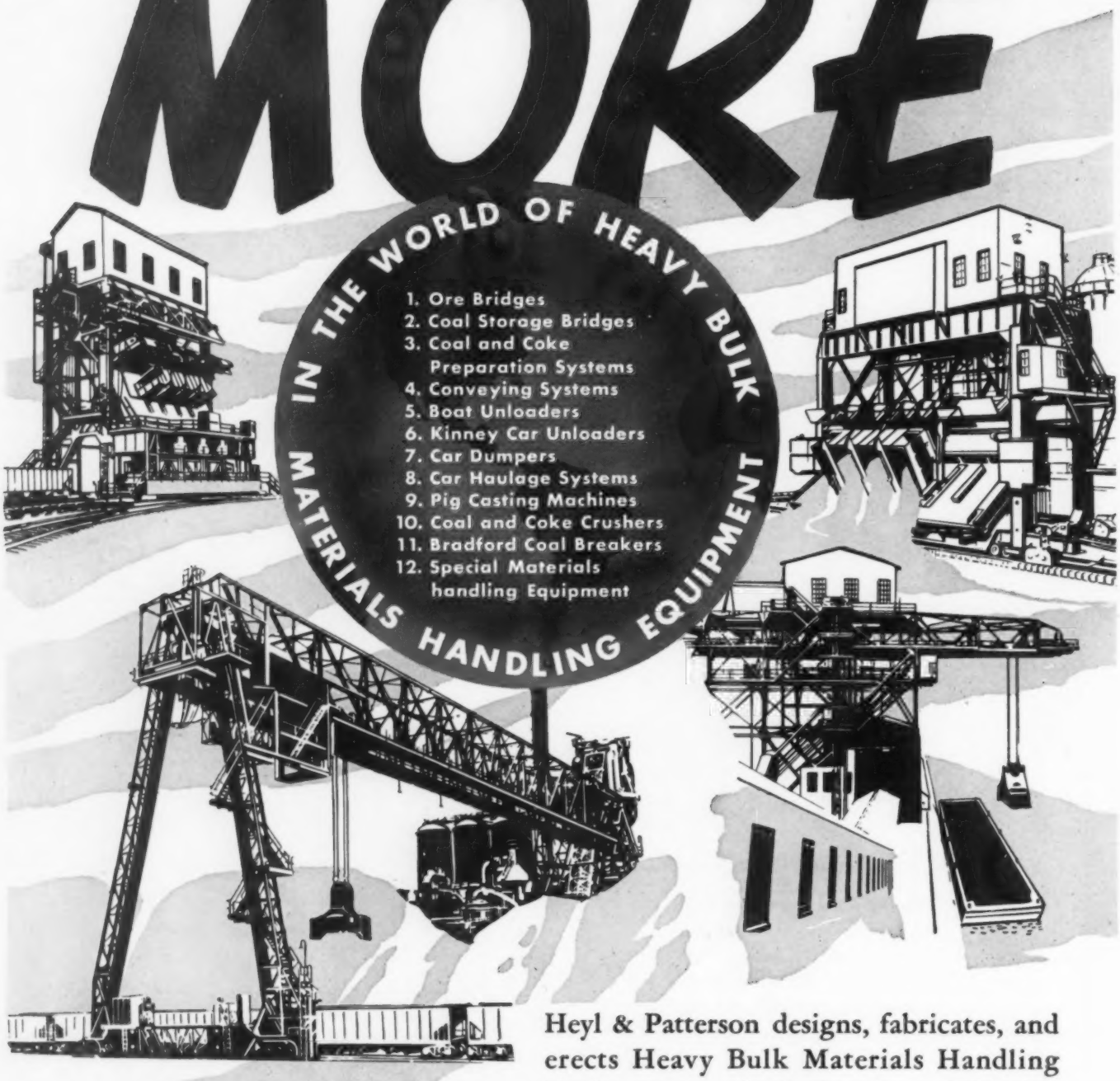
10. Coal and Coke Crushers
11. Bradford Coal Breakers
12. Special Materials handling Equipment



Heyl & Patterson designs, fabricates, and erects Heavy Bulk Materials Handling Equipment on the basis of . . . "This job must be superior to the best we have ever produced. It must contain MORE MODERN IMPROVEMENTS to meet your demands for increased production."

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"SINCE 1887"

55 WATER STREET · PITTSBURGH 22, PA

C. B. Cook has been elected president, and **Elmer F. Twyman,** vice president for 1951 of the Electric Industrial Truck Association; **William Van C. Brandt,** the association's managing director, was re-elected secretary and treasurer. Mr. Cook, vice president and export sales manager of Elwell-Parker Electric Co., Cleveland, Ohio, succeeds **M. W. Heinritz,** of Trenton, N. J., vice president of Gould-National Batteries, Inc. Mr. Twyman, vice president in charge of the Philadelphia division of Yale & Towne Manufacturing Co., succeeds **M. W. Merrick,** vice president and sales Manager of Elwell-Parker Electric Co.

Howard Kuhn, well known throughout the forging industry for more than 30 years, has joined the sales department of Heppenstall Co., Pittsburgh, Pa. Mr. Kuhn entered the forging business in 1917 when he joined the sales staff of Erie Forge Co., Erie, Pa. Two years later he became associated with Camden Forge Co., Camden, N. J. He resigned as sales manager of Camden Forge to join Heppenstall Co.

Carl H. Krause has purchased the Blue Seal Asbestos Corp., Brooklyn, N. Y. and will function as its president. Until this time, Mr. Krause was New York works manager for the Trumbull Electric Mfg. Co., a General Electric Affiliate with manufacturing facilities in Maspeth, Long Island.

Walter H. Sarraf has been appointed to the Pittsburgh district sales staff of Harbison-Walker Refractories Co. Mr. Sarraf has been associated with the company's sales department since 1930, having served as sales statistician and correspondent.

Obituaries

Alexander D. Brodie, 52, superintendent of plate and hot strip mills, Steel Co. of Canada, Ltd., died December 23. Mr. Brodie had formerly been superintendent of the 93-in. cold strip mill at Pittsburgh, Pa., works of Jones & Laughlin Steel Corp.

G. Walter Sanborn, vice president in charge of purchasing and traffic, United Engineering and Foundry Co., Pittsburgh, Pa., died December 15, 1950.

Frank J. Itts, 54, assistant supervisor of employment for the Youngstown district of Youngstown Sheet and Tube Co., died recently.

John S. Rowan, chairman of the board of the Rowan Controller Co., Baltimore, Md., and publisher of *The Camera* Magazine died December 5.

Join MARCH OF DIMES
JANUARY 15-31
FIGHT INFANTILE PARALYSIS
PATIENT CARE
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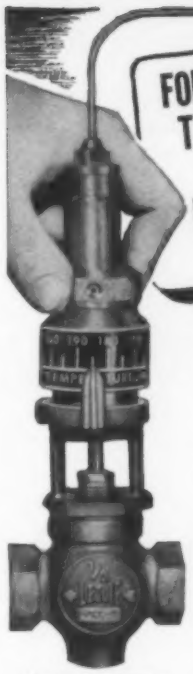
FOR QUICK, EASY, DEPENDABLE TEMPERATURE SETTINGS... the New LESLIE Calibrated Dial is the Answer!!

The new *CALIBRATED DIAL* now available on Leslie Class T and Class M Temperature Regulators provides quick, easy and dependable temperature settings.

Features

★ **TIME SAVING**—*Just turn the dial to the desired setting—no waiting for equipment to heat up to find out if setting is correct.*

★ **SAFE**—*Avoids costly overheating caused by guess setting.*

★ **RUGGED**—*Designed for production line use where frequent dependable readjustments are necessary.*

★ **SIMPLE**—*Fits in place of standard adjusting sleeve. No complicated mechanism to go out of order.*

LESLIE Temperature Regulator Class MCC-1

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ESTABLISHED 1900 LESLIE CO. FIFTIETH ANNIVERSARY 1006

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FLOATLESS LEVEL CONTROLS • PUMP GOVERNORS
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WHAT'S THE BEST WAY TO CLEAN LARGE METAL PARTS?

This FREE Oakite Booklet Tells How

HERE'S an easy way to clean metal parts that are too large to be soaked in tanks or conveyed through washing machines.

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ALSO *ask about Oakite procedures for:*

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Mills Superintendent
Bethlehem Steel Co.
Johnstown, Pa.

HOWARD E. BROWN
Supervisor Mechanical Shops
Bethlehem Steel Co.
Lackawanna, N. Y.

RAYMOND A. BURKHART
Design Engineer
Carnegie-Illinois Steel Corp.
(Construction Engr. Bureau)
Pittsburgh, Pa.

HOWARD E. CLARK, JR.
Lead Draftsman
Bethlehem Steel Co.
Lackawanna Plant
Lackawanna, N. Y.

FLETCHER M. COOK
Squad Leader, Engineering Department
Tennessee Coal, Iron & Railroad Co.
Ensley Works
Birmingham, Ala.

WILLIAM L. DANLER
Assistant Foreman
Bethlehem Steel Co.
Lackawanna, N. Y.

LEONARD G. DENNICK
Lead Draftsman
Bethlehem Steel Co.
Lackawanna, N. Y.

W. E. DITTRICH
Superintendent
Plant No. 2 Mills Department
Inland Steel Co.
East Chicago, Ind.

DANIEL C. DUHAN
Foreman, Electrical Department
Bethlehem Steel Co.
Lackawanna, N. Y.

LEONARD H. EDWARDS
General Foreman, Sintering Plant
Bethlehem Steel Co.
Lackawanna, N. Y.

FRANK E. FAIRLEY
Assistant Mechanical Superintendent
M & E Department — Sheet Mill
Tennessee Coal, Iron & Railroad Co.
Fairfield, Ala.

PAUL HEILIG
Crane Inspector
Bethlehem Steel Co.
Lackawanna, N. Y.

H. C. HOUGHTON
Assistant to Manager of Personnel
Bethlehem Steel Co.
Bethlehem, Pa.

PRESTON E. JORDAN
Technical Advisor
Wheeling Steel Corp.
Steubenville, Ohio

I. M. KUNERTH
Superintendent, Cold Strip Mill
Bethlehem Steel Co.
Lackawanna, N. Y.

PAUL E. LINDBERG, JR.
Melting Superintendent
McLouth Steel Corp.
Trenton, Mich.

HERBERT L. LINKNER
Planning Engineer
Bethlehem Steel Co.
Lackawanna, N. Y.

ANTHONY A. MALECKI
Squad Leader
Bethlehem Steel Co.
Lackawanna, N. Y.

AUGUST MELLER, JR.
Draftsman
Tennessee Coal, Iron & Railroad Co.
Ensley, Ala.

MILTON E. MOSHIER
Assistant to General Manager
Bethlehem Steel Co.
Lackawanna, N. Y.

JAMES V. NOBLE
Electrical Foreman, Group Maintenance
Bethlehem Steel Co.
Lackawanna, N. Y.

FRED OTT
Foreman
Locomotive Repair Department
Bethlehem Steel Co.
Lackawanna, N. Y.

ROBERT I. PAUL
Electrician
Bethlehem Steel Co.
Lackawanna Plant
Lackawanna, N. Y.

NED RADJENOVICH
Mechanical Expeditor
Bethlehem Steel Co.
Lackawanna, N. Y.

JAMES RAMSEY
Foreman
Bethlehem Steel Co.
Lackawanna, N. Y.

E. ESPE RESSLER
Draftsman
Jones & Laughlin Steel Corp.
Cleveland, Ohio

ARCHIE G. ROBERTS
Detailer
Tennessee Coal, Iron & Railroad Co.
Birmingham, Ala.

LOYAL D. WARREN
Draftsman
Tennessee Coal, Iron & Railroad Co.
Birmingham, Ala.

H. C. WHITE
Development Engineer
Park Gate Iron & Steel Co., Ltd.
Rotherham, England

WINTHROP S. WORCESTER
General Foreman
Carpenter, Pattern, and Plant Shops
Carnegie-Illinois Steel Corp.
Duquesne, Pa.

Associate

ROBERT D. ADAMS
Sales Engineer
The Louis Allis Co.
Chicago, Ill.

JOSEPH N. BANKY
Sales Engineer
Allis Chalmers Manufacturing Co.
Chicago, Ill.

FRANZ BARTU
Chief Engineer
Maerz Ofenbau Gesellschaft M.B.H.
Millstatt, Carinthia, Austria

HAROLD F. DAHL
Sales Engineer
Foote Bros. Gear & Machine Corp.
Chicago, Ill.

HENRY C. ELLERMANN
Chief Engineer and Roll Designer
Pittsburgh Rolls Division
Blaw-Knox Co.
Pittsburgh, Pa.

C. S. FISCHER
District Representative
D. O. James Gear Manufacturing Co.
Pittsburgh, Pa.

RONALD E. GRINDER
Sales Representative
The Adalet Manufacturing Co.
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J. E. HARRIS
Vice President
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ROBERT E. HOOVER
Sales Agent
Tool Steel Gear & Pinion Co.
Detroit, Mich.

SIGURD T. JOHNSON
Assistant Chief Engineer
Western Engineering Department
American Smelting & Refining Co.
Garfield, Utah

HAROLD W. JONES
Manager, Cleveland Branch
Kurt Orban Co., Inc.
Cleveland, Ohio

PAUL B. MOORE
Manufacturers' Representative
Youngstown, Ohio

GEORGE E. MYERS
Electrical Engineer
Aetna-Standard Engineering Co.
Youngstown, Ohio

C. PORTER PACKARD
Sales Manager
Crocker-Wheeler Division
Elliott Co.
Ampere, N. J.

WALTER A. SMIGEL
General Manager
R. H. Miller Co., Inc.
Homer, N. J.

R. N. STOTHERT
Consulting Engineer
Sheffield, Yorkshire, England

R. E. UPTEGRAFF
President
R. E. Uptegraff Manufacturing Co.
Pittsburgh, Pa.

NASH WALTERS
Service Manager
Speer Carbon Co.
St. Marys, Pa.

GEORGE P. WILLIAMSON
Chief Engineer
Crocker-Wheeler Division
Elliott Co.
Ampere, N. J.

LOYAL JOHNSTON MURPHY
Consulting and Application Engineer
Westinghouse Electric Corp.
Buffalo, N. Y.

H. W. PETTY
District Manager
Carbone Corp.
Pittsburgh, Pa.

W. S. STAMP
Sales Engineer
Clark Controller Co.
Gary, Ind.

ARTHUR M. GRASSE
Manager
Industrial Manufacturing Division
Goodman Manufacturing Co.
Chicago, Ill.

RALF W. GREENWOOD
Junior Application Engineer
Brown Instrument Division
Minneapolis-Honeywell Regulator Co.
Philadelphia, Pa.

L. H. JOHNSON
Sales Engineer
Cutler-Hammer, Inc.
Youngstown, Ohio

J. WILLIAM JOST, JR.
Design Engineer
Birdsboro Steel Foundry & Machine Co.
Birdsboro, Pa.

HUGH S. KELLEY
Sales Department
Agair Equipment, Inc.
Chicago, Ill.

H. V. KENNY
President
Auto Dealers Equipment Co.
Detroit, Mich.

C. F. KLAGES
President
G. N. Klages & Son, Inc.
Zelienople, Pa.

EDGAR C. KRAHNKE
Sales Engineer
Richard C. Remmey Son Co.
(Refractories)
Philadelphia, Pa.

Publication Service...

JANUARY, 1951

(1) "An Engineering Achievement" . . .

. . . is the title of a new 18-page book in color showing every detail of new and improved electric pallet truck. The new Model "W" truck is a compact, powerful, pallet-type unit specially engineered to handle pallet-loads weighing up to 4000 lb. Among the new and advanced features of this fast, agile, highly maneuverable truck is a new contactor panel, a positive-action brake with foolproof deadman control, improved differential action, and all-rubber, dual trailer wheels for smoother operation. (SP5.) Towmotor Corp.

(2) Motive Power Batteries

"Ironclad Batteries for Motive Power Service," a new catalog describing the performance and utility of storage batteries for users of materials handling and haulage vehicles, has been announced. The catalog consists of an information booklet and five data pages, the latter listing specifications of Exide "Ironclad" batteries, accessories and miscellaneous parts. All pages are punched for convenient insertion in standard loose leaf binders. According to the company, this new catalog was designed for the particular needs of purchasing departments and for key personnel connected with the specification and purchase of motive power batteries. Leading off the information booklet is a list of user benefits for these batteries, illustrated by high power availability and uniform speed charts. Next, an easy reading, detailed description of the battery and its features gives the reader a behind-the-scenes view of what makes a motive power battery tick. Particular emphasis is given to the slotted tube positive plate, an exclusive feature of the battery. Other items covered include the grid type negative plate; the "Mipor" separator; rubber jars and covers; vent plugs and connectors; and trays. It is pointed out that the latter are coated with the company's recently announced paint which resists both corrosion and abrasion. Long term service records are reproduced to show the durability of motive power batteries over extended periods of time. Electric Storage Battery Co.

You Can Obtain...

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(3) Hand and Foot Valves

A new technical bulletin has been issued describing 1/4 in. and 3/8 in. 880 Series hand and foot valves. Installation data, engineering drawings and explanations of interchangeability of parts and ease of modification are included. The 880 Series was developed for quick control of small cylinders and for pilot operation of master valves. (303.) Ross Operating Valve Co.

(4) New Periodical

A new publication, designed to present current technical and operating information on heat treating metallurgy and practice, has been instituted by Surface Combustion Corp. This bulletin, entitled the "Heat Treat Review," is to be published periodically by Surface Combustion and distributed to all persons concerned with heat treating operations. The magazine is intended to provide up-to-date information on heat treating processes as applied to all phases of the metal-working field. Metal melting and related metal processing activities are also to be covered in this bulletin. Industrial metallurgists and heat treaters are offered this magazine on a gratis basis.

(5) Lifting Magnets

Just issued is a 6-page catalog describing new lightweight all-welded lifting magnets. This literature gives features, size ranges, lifting capacities, dimensions and ratings of the new magnet. Also included is a cross-sectional drawing detailing construction features, materials and design. Types of controllers for the magnet are illustrated and explained. Installation photographs show some of the types of work in which the new magnet is now being employed. (B-1401-A.) Dings Magnetic Separator Co.

(6) Induction Motors

Construction features of large two-pole squirrel cage induction motors are given in a new bulletin just released. A cross section view of a typical normal torque, low starting current motor shows the construction of stator winding, bearings, ventilation, squirrel cage winding, rotor, stator, and bearing brackets. This is supplemented by additional photographs of motors and motor parts. The construction features described in the bulletin are available in standard 40 C rise continuous rated, two-pole, 60-cycle, 3,600-rpm, bracket-bearing, squirrel cage motors for direct-connected drives in all ratings 900 hp and larger.

These motors are built for boiler feed pumps, oil pipeline pumps, centrifugal blowers, descaling pumps, and other high speed drives. (05B7550.) Allis-Chalmers Manufacturing Co.

(7) Argon Welding

A new booklet, "Procedures and Equipment for Argon Metal Arc Welding," describes the apparatus for this new welding method, which uses argon gas to shield the consumable filler metal electrode and the welding area. The features, work range, and photographs of this welding equipment are included in this 6-page booklet. Linde Air Products Co.

(8) Reducing Valve

A new 6-page bulletin containing complete technical information on a cushioned water pressure reducing valve is now available. The bulletin features the general arrangement of the valve and the reducing pilot valve, with a detailed list of parts. The installation,

operation, adjustment, servicing and specifications are fully described, along with tables showing general dimensions, approximate shipping weights and general list of materials. (W-3.) Golden-Anderson Valve Specialty Co.

(9) Push Button

A new bulletin lists a new push button for hazardous locations. The push button is equipped for conduit entrance, either top or bottom. This button is the same as the well-known push button which has been available with conduit entrance only at the top. The new button will permit direct conduit entrance from below without requiring angular fittings. These buttons may be used as air-break or with contacts oil-immersed. A screwed-on tank forms the bottom half for quick access to the interior connections. The threads are of special construction to meet the requirements of permissible enclosures. The bulletin gives ratings, dimensions and complete information. (1105-C.) Electric Controller and Manufacturing Co.

(10) Time Proportioning Relay

A specification sheet is available describing the "Electr-O-Pulse" time proportioning relay with automatic reset. The relay provides time-proportioning control — controlling by variation of the on-off time ratio of a contacting device — with automatic reset. This relay is particularly useful for industrial heating applications where full heat input during the "on" period is desired for reasons of economy and process requirements. Manual control as well as independent adjustments for reset rate, approach rate, and proportional band are provided. The relay is designed for use with electric proportional controllers, usually for control of electric furnaces but sometimes with certain fuel-fired furnaces. (195.) Brown Instruments division, Minneapolis-Honeywell Regulator Co.

(11) Unit Heater Code

Bulletin No. 10, the "Standard Code for Testing and Rating Steam Unit Heaters," second edition, has just been released by the Industrial Unit Heater Association. It supersedes the first edition, 1930, which was prepared and adopted jointly by the Association and the American Society of Heating & Ventilating Engineers. The second edition is issued under the same authorities. The fundamental engineering has not been changed. Improved testing equipment, instruments and technique have developed through the years and the purpose of the second edition is to recognize them. After complete laboratory tests these advances have been incorporated in the Code. Those interested will find that this 19-page publication covers the subject in full detail. (10.) Industrial Unit Heater Association.

(12) Wire Rope

A new bulletin gives quick reference of all information pertaining to improved plow steel wire rope. All sizes and construction classifications are combined in one large table. This is probably the first time that this data has ever been assembled in this manner. Several changes have been made in information which has been brought up-to-date in this latest bulletin. This bulletin contains information on how to order wire rope, and explains and describes wire rope constructions. (50-25.) Macwhyte Co.

(13) Flame Hardening Catalog

A new flame hardening apparatus catalog has been announced. Descriptions and illustrations of the latest flame hardening equipment are contained in this 20-page catalog. It has been expanded to include a section on "Tips for the Production Flame Hardening of Special Shapes." Gas control equipment and pipeline systems are discussed. Air Reduction Sales Co.

(14) Oil Burners

A bulletin is available describing hand control burners. The Series "F" Oil Burners are the low pressure air type for industrial applications requiring a 10 to 1 turn down in firing capacity with manual and individual control of oil and air. Better circulation of heated heavy oil is had with the built-in metering oil valve and oil recirculating connection. (411.) Hauck Manufacturing Co.

(15) Materials Handling Equipment

A condensed catalog containing basic specifications of an entire line of materials handling equipment is announced. Models listed include fork-lift trucks, both gas-powered and electrics, on solid tires and pneumatic tires; industrial towing tractors; tructractor models for handling bulk materials; and the complete line of twenty special attachments designed for particular needs. Fork truck specifications cover capacity, turning radius, load center, minimum intersecting aisle, truck dimensions, fork length, upright heights (low to high), fork lift heights (low to high) and service weight. Tractor specifications include drawbar pull, capacity in tons, turning radius, overall dimensions, tire sizes and weight. Tructractor specifications give capacities in cubic feet and pounds, turning radius, overall dimensions, body dimensions and weight. (TC-44.) Industrial Truck division, Clark Equipment Co.

(16) Centrifugal Pumps

Complete information on a new self-priming centrifugal pump line is now available in a catalog. The pumps are of a new design that eliminates valves and yet gives efficiency comparable to standard centrifugal pumps. These self-priming pumps are made in sizes ranging from ¼ hp to 5 hp with both open and closed impellers. Capacities to 120 gpm and heads to 135 ft depending upon capacity. They can handle suction lifts up to 25 ft. (636.1) Goulds Pumps, Inc.

(17) Tungsten Carbide Metal

Metal Carbides Corp. announces an attractive new plastic wall hanger, 9 x 12 in., showing and describing how tungsten carbide metal is made. It will be sent free-of-charge to any customer or prospect. Suitable for hanging on wall or standing on a desk anywhere, in the shop office or executive suite, the plaque explains graphically and completely the steps in preparation of tungsten carbide metal by either the hot press metal or the cold press method.

(18) Conveyor Belts

Featured by illustrations which portray in detail all major parts used in construction of its line of conveyor and elevator belts, Goodrich Co. has just issued a new 26-page catalog section on the subject. Copies can be obtained upon request. The publication de-

scribes all belt features, explains why increased service life with decreased maintenance are made possible by the construction and tells the function which each part of the belt performs, as well as significant data on each belt in the company's line. The products described are conveyor and elevator belts, cord conveyor belts, material conveyor belts, hot material conveyor belts, oil service conveyor belts, package conveyor belts, food handling conveyor belts, grain conveyor and elevator belts, industrial elevator belts and special conveyor belt constructions. (2200.) B. F. Goodrich Co.

(19) Gear Drives

A new packaged power unit called "Motogear" is described in a new booklet that is available. This unit consists of a compact, enclosed helical gear drive with separate standard motor, flexibly coupled and mounted on one welded steel base plate. A movable plate between motor feet and welded base plate provides for convenient adjustment, according to the booklet, should shaft realinement be necessary for any reason. These gear drives are built in a variety of sizes, in double or triple reductions, and in a wide range of ratios and horsepowers. Input and output shafts are concentrically in line. (2247.) Link-Belt Co.

(20) Pre-Lubricated Bearing Design

Reliance pre-lubricated bearing design, which provides more hours of motoring operating life without relubrication than any other pre-lubricated bearing, is the subject of a bulletin recently published. The illustrated folder contains descriptive sketches, cutaway drawings of the improved double shielded bearings and their bracket mounting, and a check list which compares other bearing arrangements with the Reliance design. (B-2201.) Reliance Electric and Engineering Co.

(21) Liquid Level Controls

A catalog is available describing "Magnetrol" liquid level control for practically any liquid at any pressure or at any temperature. This catalog discusses the switching principle used in "Magnetrol" controls, the advantages of this control, and how it works. It also describes the various types of level controls available as well as giving standard and special applications. Magnetrol, Inc.

(22) Master Control System

A bulletin is available describing the "Telemaster," a new electronic master control system. This system is new in design and is a completely flexible system. It offers complete freedom of control centralization, simplified and smaller control panels, elimination of transmission lags, no panel piping, reduced maintenance and many more direct advantages. This control system can be used in many applications in the combustion and power plant end of the steel plant. (1100.) Republic Flow Meters Co.

(23) Industrial Furnaces

Marking the end of one hundred years of industrial furnace manufacture and the beginning of its second century of business life, Swindell-Dressler Corp., has published an illustrated historical review of the company's activities. The brochure describes the early work of William Swindell and brothers in building puddling and forging furnaces for Pittsburgh ironmakers, the first regenerative gas furnace in America, and regenerative crucible furnaces — over 90 per cent of the latter furnaces used in the United States were built by Swindell, it is stated. The history contains a section on the development of electric heating and melting furnaces, in which much pioneering was done by the company, and reviews the origins of the American Dressler Tunnel Kiln Co. prior to its merger with William Swindell & Bros. in 1930. Since that date, Swindell-Dressler Corp. is seen to have widened its operations to cover not only the construction of annealing and electric melting furnaces, and kilns, but also the design and construction of complete plant installations.

(24) Industrial Trucks

A new 8-page descriptive bulletin just released translates into user benefits the design and construction features of fork trucks in 3000 and 4000 lb capacity. Designed to give the reader complete information, this bulletin contains: pictures and descriptions of major components of the trucks; dimension drawings showing maneuverability; detailed specifications; pictures and descriptions of features that assure ease of handling and maintenance; pictures of these trucks working in 8 different industries and 16 different applications; and, illustrations of 14 of the many attachments which can be applied to the trucks for the handling of material in sizes, shapes and forms not practical with standard forks. (1324) Baker Industrial Truck division of Baker-Raulang Co.

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50	BAILEY METER CO.	BULLETIN 211	Describes Bailey smoke density recorder.
51	BEDFORD FOUNDRY AND MACHINE CO.		Catalog available on Bedford cranes.
52	BLOOM ENGINEERING CO., INC.	BULLETIN 1081	Gives complete details on the Bloom HTR burner.
53	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Describes Browning mill type cranes.
54	CITIES SERVICE OIL CO.		Bulletin available on combustion control for industry.
55	DE LAVAL STEAM TURBINE CO.	CATALOG 05-13-R	Describes in detail De Laval blowers.
56	ELECTRIC CONTROLLER AND MFG. CO.	BULLETIN 942	Gives the facts on EC&M TAB-WELD plate resistors.
57	ELECTRIC SERVICE MANUFACTURING CO.		Catalog available on Keystone industrial products.
58	FARREL-BIRMINGHAM CO., INC.	BULLETIN 115	Describes the features of the Farrel heavy duty roll grinder.
59	FARVAL CORP.	BULLETIN 25	Gives full details on the Farval centralized lubrication system.
60	FELT PRODUCTS MANUFACTURING CO.		Complete data sheet and free sample of the new Fel-Pro thread compound is available.
61	FURNACE ENGINEERS, INC.		Bulletin available covering all types of F.E.I. heat treating furnaces.
62	GENERAL ELECTRIC CO.	BULLETINS GEC-471 AND GEC-485	Gives full information on the G-E X-ray thickness gage.
63	HAGAN CORP.		Bulletin available on the Hagan ratio totalizer.
64	HOMESTEAD VALVE MANUFACTURING CO.	CATALOG 39-5	Complete facts available on the Homestead-Reiser self-seald valve.
65	IDEAL INDUSTRIES, INC.		Handbook available on commutator and slip ring maintenance.
66	KOPPERS CO., INC.		Shows the operation, sizes and types of Fast's couplings.
67	LESLIE CO.	BULLETIN 464B	Describes Leslie temperature regulators.
68	NATIONAL BEARING DIVISION, AMERICAN BRAKE SHOE CO.		Catalog tells how complete facilities for research, engineering and production can reduce costs of non-ferrous parts in the plant or product.
69	NATIONAL ERIE CORP.	BULLETIN 7	Catalog available on industrial gears.
70	OAKITE PRODUCTS, INC.	FOLDER F7338	Gives details on the Oakite steam gun.
71	OKONITE CO.	BULLETIN IS-2009	Contains detailed information about Okonite's unique manufacturing methods and policies.
72	PITTSBURGH LECTROMELT FURNACE CORP.	BULLETIN 7	Gives further data on lectromelt furnaces.
73	POOLE FOUNDRY AND MACHINE CO.		Catalog available on flexible couplings.
74	POST-GLOVER ELECTRIC CO.	BULLETIN 500	Gives detailed information on P-G grid resistors.
75	ROCKBESTOS PRODUCTS CORP.		Tells the full story of the Rockbestos insulation.
76	SQUARE D CO.	BULLETINS 9003 AND 7950	Describes Square D mill-type master switches.
77	TRABON ENGINEERING CORP.		Shows how Trabon lubricating systems can save thousands of dollars.
78	WAGNER ELECTRIC CORP.		Bulletins available giving full information on Wagner motors.

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...thousands of Cancer patients are grateful to you!

Cancer's annual toll of 200,000 lives is grim proof of the need for your continued generosity. The money you contribute to the American Cancer Society helps pay for the development of methods of treatment which are now saving about one-quarter of the people who are stricken with Cancer... people who might otherwise have died. Your money supports the work of more than a thousand specialists who are fighting to find the cause and cure of Cancer. And it finances a vast education program that trains professional groups, tells the public how to recognize Cancer and what to do about it.

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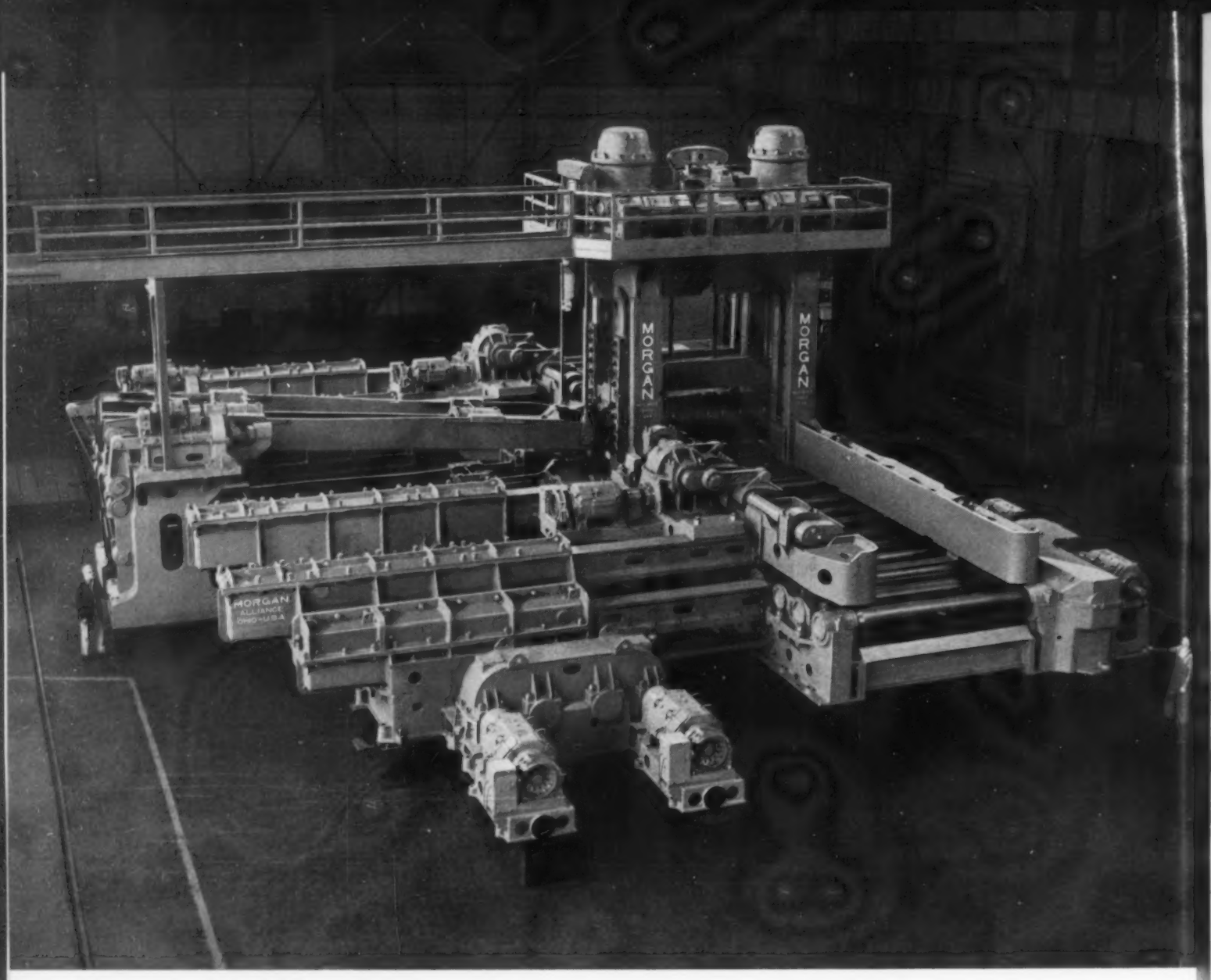
Just write "CANCER" on the envelope containing your contribution. It will be delivered to the American Cancer Society office in your state.



44" TWIN MOTOR DRIVE BLOOMING MILL

Morgan 44"—2 High Reversing Blooming Mill to be direct connected to two 4000-Hp., 50/120 Rpm. Motors. Top roll and both spindles are hydraulically balanced by individual cylinders connected to an air hydraulic system. Speeds of motor driven screw down, feed rollers, mill tables and manipulator are regulated by variable voltage control.

Mill tables have box type cast steel girders. Rollers are forged steel equipped with anti-friction type bearing cartridges. All gears have hardened teeth, are totally enclosed and operate in oil. Manipulator is of the electric overhead type with retractable heads affording maximum accessibility to all parts of the mill tables.

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Equipment News...

TWO-WAY RADIO KEEPS INDUSTRIAL TRUCKS BUSY CARRYING PAY LOADS

▲ Use of two-way radio as an aid to mechanized materials handling is saving American industry thousands of dollars this year.

The new technique accomplishes two purposes: it keeps industrial trucks busy carrying payloads, instead of wasting time deadheading; and it moves them to busy spots where they are needed without a wasted minute.

One firm putting the idea to work is the Johnson & Johnson Co., whose new shipping center at Metuchen, N. J., already has been hailed as one of the finest examples of modern handling yet devised. It is in the same structure that two-way radio is establishing new and happy returns.

The operation involves receiving goods from its production plants, moving them to reserve areas, or the order picking floor, and to loading docks for shipment to customers. Rail and highway transportation is used.

Internal handling, except for a dragline operating in the order picking area, is by a fleet of seven "Skylift" electric fork trucks, 2,000 lb capacity, made by the Automatic Transportation Co.

Here's how the operation was set up:

Two-way short wave radio sets were installed on each of the electric trucks. They are placed to the right of the driver's seat, and are easily accessible. All sets, plus the master station from which all orders emanate, are on the same frequency. Thus, every driver hears all messages, and can better orient himself to the entire operation.

A master short wave station is located in central dispatching headquarters, which is both the voice and brain of the materials handling system. Included are a space layout chart and stock record location cards. The dispatcher knows where all merchandise is, can keep up to the minute on the positions of his fleet, and is able to shift trucks and goods with exceptional speed.

For Johnson & Johnson, the radio equipment and its installation cost $3,200. The operation is too new for time study figures to tell how rapidly savings achieved by the radio-electric truck combination are paying for the communications system. However, the company asserts that dollar benefits are appreciable, and already indicate a considerable accomplishment.

A master short wave station is located in central dispatching headquarters.

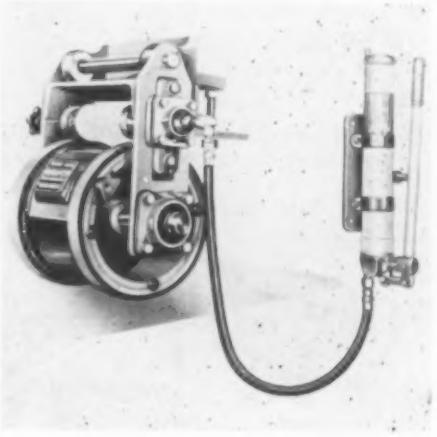
COIL AND SHEET PRINTER REPLACES HAND MARKING

▲ A coil and sheet printer has been developed by Jas. H. Matthews & Co., in cooperation with the men in the strip steel mills, for the automatic imprinting of trademarks, heat numbers and inspector's identification mark on each sheet or coil as it emerges from the temper mills or shear lines. Thus, it replaces the former slow method of marking with a hammer-style inspector's rubber stamp.

This new unit is fundamentally a revolving cylinder, to which a rubber printing die is fastened. As the cylinder is revolved by the rubber drive tires in contact with the steel passing beneath, a clean, legible, inked impression is made.

The coil and sheet printer is suitable for permanent or water soluble marking on all types of steel run or temper mills, hot or cold reducing mills, or continuous galvanizing lines. It can be used for marking on a flat surface, or it can be mounted directly on top of the coil at the reel.

The outstanding development of the printer is its internal feed inking unit, which eliminates the need for brushing ink on the ink roll, and insures control of ink distribution. Ink in the fountain is readily replenished from an ink reservoir mounted nearby while the printer is in operation. Reinking of the ink roll is quickly and easily accomplished without stopping mill or line operations.



An outstanding development of this printer is its internal feed inking unit.

The printing plate locking device is another development. This is a positive, quick-acting mechanism which securely locks the printing plate into position, and eliminates the possibility of its flying off at any mill speed. By the use of Matthews' interchangeable rod-style rubber type it is easy for the operator to make quick changes of inspection and identification data. This rubber type is securely locked in the mortises of the printing plate by means of a metal pin passing through the type body. It is especially important that the type be held securely, especially when the unit is used on some of the newer high-speed temper mills,

now operating at speeds of 3000 fpm, or more.

The drive tires are made from a specially compounded rubber, which gives long, satisfactory service and does not mar or streak the finish of the steel. These rubber drive bands, in combination with the solid, well-engineered construction of the No. 216 coil and sheet printer, give the unit sufficient weight and balance to assure good printing.

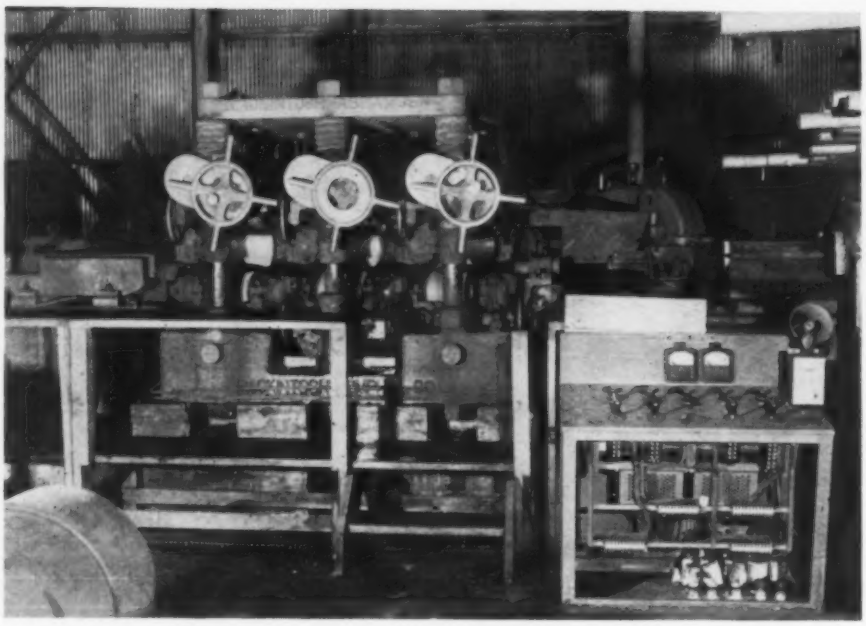
LARGE SWITCHGEAR UNIT INSTALLED AT J&L

▲ The largest metal-enclosed draw-out switchgear for heavy-duty d-c service ever built by the General Electric has been put in service in the blooming-mill motor room of Jones and Laughlin Steel Corp.'s Otis works at Cleveland, Ohio.

The switchgear consists of 18 breaker and control units which control two 1000-kw 250 volt ignitron rectifiers, a 1500-kw 250-volt motor-generator set and twelve automatic

(*Please turn to page 198*)

ROTARY STRAIGHTENER FOR BUTT WELD PIPE



Pictured is one of the two Mackintosh-Hemphill rotary straighteners in the No. 2 continuous weld mill that was opened in June, 1950 by Youngstown Sheet and Tube Co. in its Indiana Harbor, Ind., plant.

These machines will straighten 15,000 tons of from 1½ to 4 in. butt weld steel pipe in an 18-turn per week monthly production schedule. Handling pipe in lengths up to 46 ft, these Model A-2 crossed-roll straighteners have been a definite factor in the high production and quality records set up since the swinging into operation of this new, automatic and continuous pipe mill.

BOOST *ON-GAGE* TONNAGE
with G-E X-ray Thickness Gage

Now, defense demands more production and conservation of materials. General Electric's X-ray Thickness Gage by continuously gaging moving strip, enables you to—

ROLL FASTER—One mill replaced mechanical gages with G-E X-ray Gages and upped rolling speed 45%. Scrap decreased despite the speed increase.

SAVE MATERIAL—Another mill now reaches gage on the first strip. Before, as many as four strips went through before gage could be reached.

HOLD CLOSER TOLERANCE—This same mill now gets more uniform strip and says the G-E X-ray Gage will pay for itself many times.

Perhaps you can get results like these with a G-E Thickness Gage. Why not ask your G-E salesman to discuss its application in your mill?

For more information write to Section 687-60 for bulletins GEC-471 and GEC-485. *Apparatus Dept., General Electric Co., Schenectady, New York.*

▲ HEAT, STEAM, OXIDES—EVEN STRIP COBBLES—do not affect detector head of G-E Gage, here shown in position on continuous hot-strip mill.

◀ G-E X-RAY THICKNESS GAGE on continuous hot-strip mill. Operator watches an indicator which shows deviation from desired thickness and can make screw-down adjustments during rolling.

GENERAL ELECTRIC

687-60

THE ENGINEERING MART

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For application to soaking pits, heating, and other types of metallurgical furnaces.
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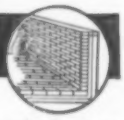

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Trial Order 10 lb. lot $3.30
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Manufacturers of
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Commutator Smoothing Stones • Undercutters • Test Loads • Most complete line of the SAFEST *Voltage Testers on the Market!*
18 North Ada Street
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Agents Wanted
Several excellent territories open.

THE ENGINEERING MART

Business Opportunities—(Cont'd)

SALES AGENCY AVAILABLE

Recently established electrical sales agency with men of many years experience and having excellent contacts with Northern Ohio steel mills, original equipment manufacturers, and other industrials wants one or two additional lines of industrial electrical apparatus. For details write Box 102, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

POSITIONS VACANT

DRAFTSMEN WANTED

Draftsmen with at least three years experience preferably in structural or fire brick masonry wanted by well established steel plant engineering and contracting firm specializing in constructing open hearth furnaces. Apply by mail: Suite 300, 610 Smithfield Street, Pittsburgh 22, Pa.

ESTIMATOR WANTED

Estimator experienced in quantity survey on fire brick, steel and concrete wanted by well established steel plant engineering and contracting firm specializing in open hearths and steel reheating furnaces. Permanent work. Location downtown Pittsburgh. Apply by mail: Suite 300, 610 Smithfield Street, Pittsburgh 22, Pa.

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for Permanent Positions
(Major Steel Producer)
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University Engineering Graduates 35 to 55, 10 years active engineering experience. Last 5 in one of following: BLAST FURNACE and OPEN HEARTH, WIRE MILL, TIN PLATE and GALVANIZING.

$600 to $800

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LUBRICATION ENGINEER

University Engineering Graduate 30 to 55, 5 years active industrial practice lubrication engineering. Full knowledge necessary.

$475 to $625

Various other openings: designers, detailers, etc. Write Box 101, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

WANTED
CONSTRUCTION SUPERINTENDENT

Thoroughly experienced in industrial work by well established Pittsburgh steel plant engineering and contracting firm specializing in open hearth furnaces. Permanent work assured through large amount of work on hand. Apply by mail: Suite 300, 610 Smithfield Street, Pittsburgh 22, Pa.

Positions Vacant—(Continued)

WANTED

CHECKERS DESIGNERS

DETAILERS PROPOSAL WRITERS

Excellent job opportunities with a leading rolling mill equipment manufacturer in the Pittsburgh district. Our people know of this ad. Write giving age, education, experience. Box 100, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

It's EASY to place a "RESULT-GETTING" Want Ad in the Engineering Mart section of the IRON AND STEEL ENGINEER.
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DISPLAY RATES: $8.00 PER COLUMN INCH.

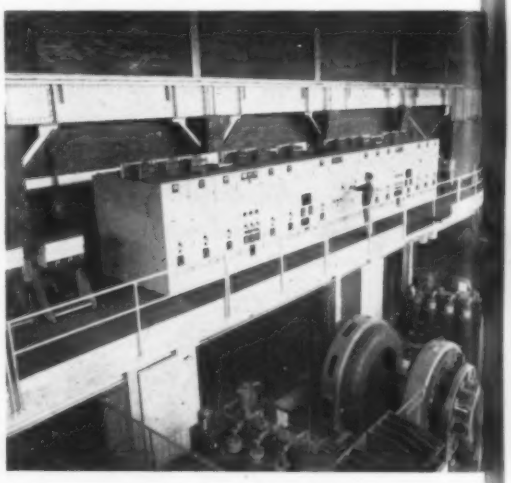
EQUIPMENT NEWS

(*Continued from Page 196*)

reclosing feeder circuits. In addition to the heavy-duty d-c breakers in the rectifier cathode circuits, the installation includes high-speed metal-enclosed drawout anode circuit breakers for the rectifiers; these are located in separate structures adjacent to the rectifiers.

The G-E switchgear divisions, which manufactured the J&L equipment, only recently extended their line of metal-enclosed switchgear to the field of heavy-duty d-c service in steel mills. The new line also meets the needs of other large industrial establishments and large d-c traction substations.

Built for use on 250- and 600-volt d-c systems in ratings up to 8000 amperes, the new line of switchgear



This is largest metal-enclosed drawout switchgear for heavy duty a-c service ever built by G-E.

equipment utilizes the heavy-duty Type MC-5 magnetic air circuit breaker in a completely metal-enclosed drawout structure. Control and measuring apparatus is mounted on swinging panels integral with the structure.

The breakers are mounted on roll-out carriages, with safety interlocks, which provide easy withdrawal for inspection and maintenance. All breakers of like ampere rating are interchangeable so that spare elements may be substituted to maintain continuous service while regular units undergo maintenance. According to G-E engineers, the entire equipment is built to withstand the extremely high values of short-circuit current encountered in large d-c power systems.

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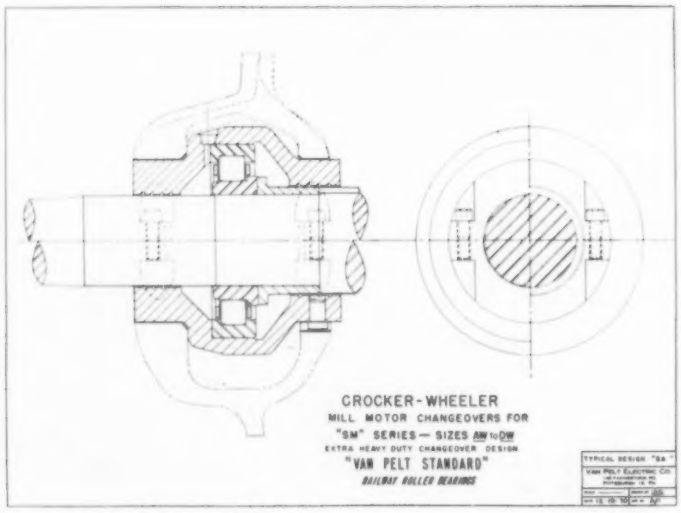
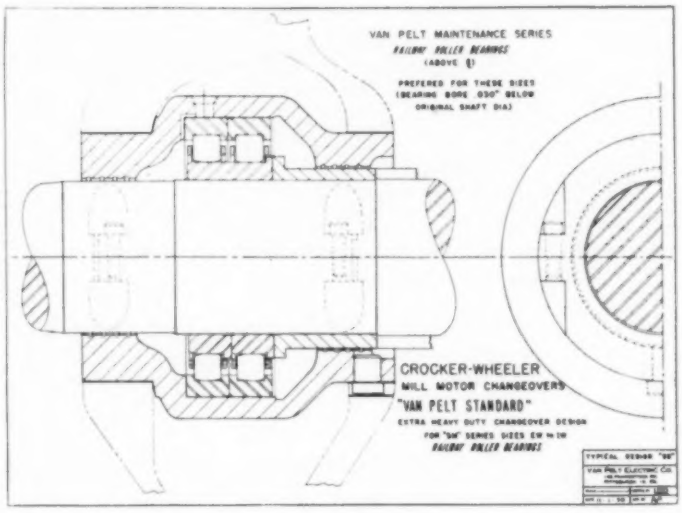
VAN PELT ★ MOTOR ★ CHANGEOVERS

★ *Bearing Changeovers for Crocker-Wheeler Type SM Mill Motors*



Typical of sizes AW to DW Crocker-Wheeler Mill Motors, this design permits the easiest of all changing-over of mill motors. Frame alterations consist of chamfering some sharp corners and preparing slot for dowel pin, additional lugs are desirable on the top and bottom frame halves for better clamping.

On the EW to IW sizes, due to space limitations, Double Row Matched Van Pelt Maintenance Series Railway Roller Bearings are employed. Old shafts can be used in all cases. There is no metalizing required; simply grind the old journal diameter to accept the new roller bearing.



All Van Pelt designs are **horizontally split** to insure absolute **parallelism** and **concentricity** between the bearing bore and the hub diameters. Over 25 years of experience has proven that features like these guarantee extra long life. Contact your local bearing distributor or our engineers for further details.

BUY THE BEST — SPECIFY VAN PELT

VAN PELT ELECTRIC CO.

105 FAHNESTOCK ROAD • PITTSBURGH 15, PA.

Farval helps sheet leveler show $2500 monthly saving

WITH this machine, a kitchen range manufacturer saves nearly $2,500 a month. It is a McKay Leveler, through which steel sheets are passed to correct irregular grain structure—a cause of breakage in deep drawing operations.

Steady, economical operation of the leveler is insured by a Farval Centralized Lubrication System. Forty-two bearings are served by a manual pumping unit.

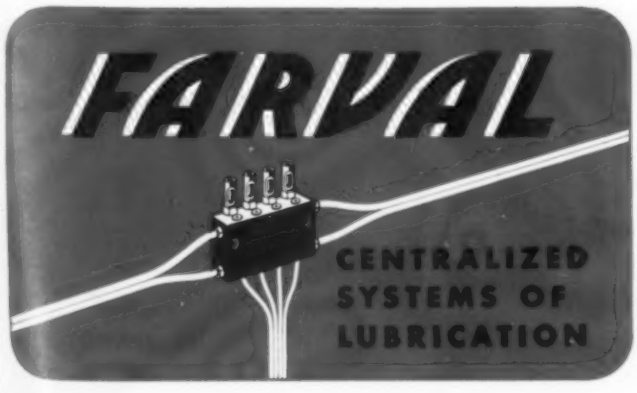
With Farval on the job, it isn't necessary to stop the machine for periodic oiling, because a few quick strokes of the pump lever once or twice each work shift lubricate every bearing—adequately and without waste. Nor is it ever necessary to shut down the leveler for repair or replacement of bearings damaged or worn out by faulty lubrication.

Just as the McKay Leveler soon pays for itself in savings, so also a Farval system on any machine soon pays for itself—by the savings it brings in bearing expense and lubricant cost, not to mention oiling labor and production time saved.

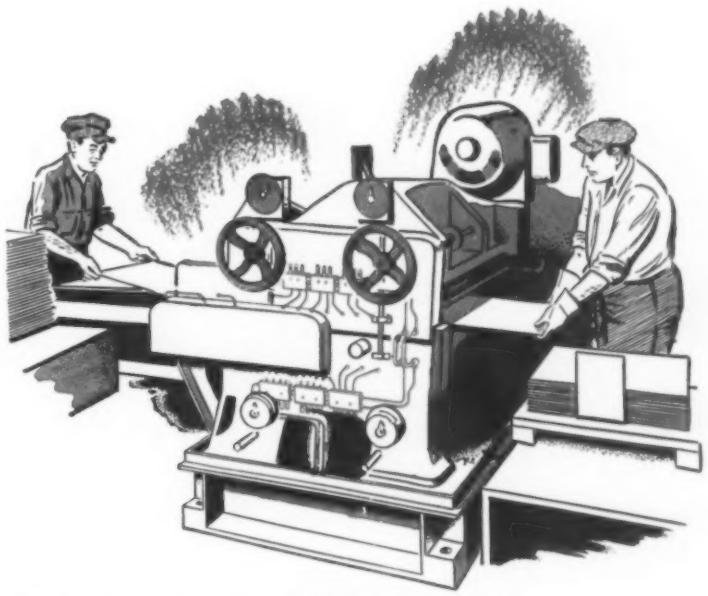
Farval is the original Dualine system of centralized lubrication, proved practical in 20 years of service. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned.

Write for Bulletin 25 for full details. The Farval Corporation, 3278 East 80th Street, Cleveland 4, O.

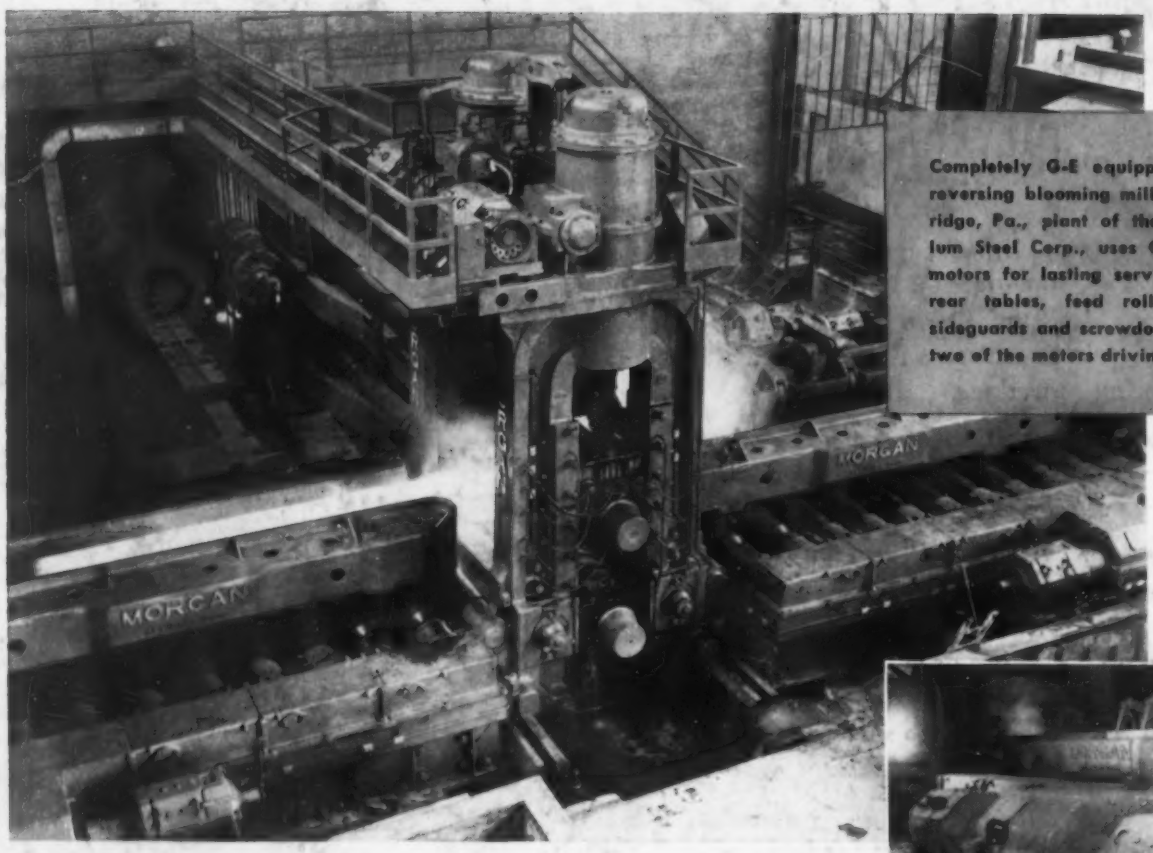
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



FARVAL—*Studies in Centralized Lubrication*
No. 118



McKay Sheet Leveler on which all bearings are Farval lubricated. Farval Centralized Lubrication Systems, manually operated and automatic, lubricate over a million bearings in the iron and steel and metal working industries alone.



Completely G-E equipped, this 40-inch reversing blooming mill at the Brackenridge, Pa., plant of the Allegheny Ludlum Steel Corp., uses G-E MD-600 mill motors for lasting service on front and rear tables, feed rolls, manipulators, sideguards and screwdowns. Inset shows two of the motors driving the front table.

OUTAGE TIME CUT

in 40" reversing blooming mill!

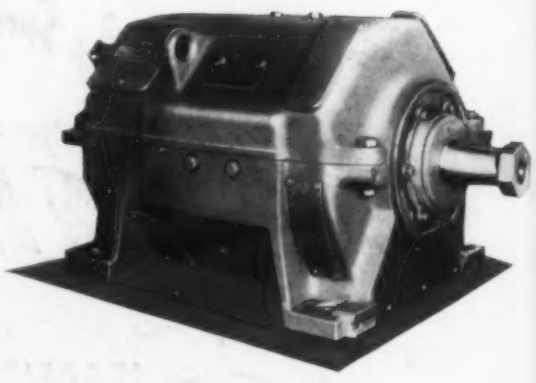
G-E d-c mill motors give day-in day-out dependability on essential auxiliaries

Here's why: Rugged construction throughout safeguards these G-E MD-600 mill motors against all kinds of steel-mill conditions. They're protected against heat of furnaces and hot metal—against mechanical shock and strain—against dirt, corrosive fumes and excessive moisture—against the effects of frequent starting, stopping and reversing. Motor life is longer, replacements fewer!

Further lengthening their service life is improved ventilation that dissipates up to 50 per cent more heat, plus mica, glass, and silicone resin insulation. Besides, compact design gives you more hp per frame size than in former types.

Here's more: G-E MD-600 d-c mill motors are available in standard mill ratings from 7½ to 200 hp to meet AISE specifications. For a detailed description of their many long-life features, write for Bulletin GEA-4654. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

MD-600 MILL MOTORS



GENERAL ELECTRIC

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